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EDITORIALS

BREVITY IN SCIENTIFIC CONTRIBUTION

No one likes a bore: in our speech we take care to avoid it but in our writing we are not so particular. We forget that " the ablest physicians, whose attention all writers want most to attract, are in the habit of quickly skimming through large numbers of articles always looking for one thing, and that is something new, significant, important and usable." [1]

After an article has been written it should be put away in a drawer and forgotten. On reading it again the writer will be appalled by the obscurity of his language and his verbosity. Unless he be one in a thousand—in which case he has missed his vocation—he will find that he must often read a sentence a second time before he knows what it says, and then translate it into simpler terms before he can grasp its meaning. " There probably never was a good paper which was not worked over several or many times. The writer will do well to search through his pages for every sentence and word that can be deleted without taking from the essential message. Every sentence that is vague should be rewritten until it can have but one meaning and that an obvious one." [1]

Let no one be afraid of short sentences and short words. Would the ten commandments be more explicit, or more expressive, if they were expanded to twice the number of words? " Say it with flowers " does not apply to the writing of scientific articles. Leave it to the politicians to say that *the answer is in the negative* and be content with *no*.

Every article is improved by being shortened. All editors are agreed on this but such is human nature that no author can believe it about his own paper. Not a paper is published in this Journal that has not been submitted to the editor's blue pencil. What is cut out? First, unnecessary words—and how many there are; second, airy suppositions unsupported by evidence—and how frequent they are; third, inconsequences—and how ubiquitous they are; and fourth, long introductions—and how tedious they are.

History is all very well in its place, but few readers are interested in what Hippocrates or Celsius wrote; those who are had better consult Bick. If you must refer to the literature, do it as briefly as you can. In these days the reader, at least the British reader, wants meat; do not dawdle over the soup. " The ablest writers try at the start to so grip the interest of the reader that he will want to go on." [1]

Illustrations are meant to illustrate. They should make clear what has been said, or convey to the reader something that cannot be conveyed by words. Every illustration should have a purpose; it is not inserted for its beauty; it must earn its place. An amusing occupation is to look through any article in any Journal and count the worthless illustrations.

One remark on grammar. A sentence is entitled to subject and verb but many would-be contributors deny it the one or the other. Note again the first sentence of this paragraph.

Allow me to give one final word of advice. Before submitting a paper to this Journal for publication, buy Fowler's *Modern English Usage* and paste in it a copy of the article by Dr Alvarez from which we have quoted freely. The editor will get to bed earlier, his temper will be sweeter, and his blue pencil will last longer. You yourself will rise in the estimation of your readers.

GEORGE PERKINS.

[1] ALVAREZ, I. (1949): Proceedings of Staff Meetings of the Mayo Clinic, August 17, 1949.

THE HAND AND FOREARM

Most of the advances in the surgery of the hand are being made by comparatively young surgeons, none of whom would fail to acknowledge the stimulus derived from the mature work of Bunnell. Nevertheless, of the spontaneous writings collected in this number into a "symposium," few deal with the surgery of repair, and their variety illustrates the catholicity of the interests in this confined anatomical field.

The first fifteen articles have fallen into a natural sequence. First comes a report on infections of the fingers by the staphylococcus, and everyone agrees on the urgent need for garrotting this invader before it learns to counter every antibiotic weapon we possess. Next comes a disturbing review of the variable distribution of the median and ulnar nerves in the hand, disturbing at least to those who rely on a few simple tests for the integrity of these nerves. Its companion article deals with the "bail-graft" for the *main-en-singe* deformity of thenar paralysis. Then come four papers, paired like theorem and corollary, on the semilunar bone and the carpus. The next group of articles deals very completely with osteoarthritis of the trapezio-metacarpal joint: first the radiology; then the treatment by external splintage, arthroplasty or arthrodesis; and finally the congenital defects of the region. Strangely enough there is hardly a mention of Bennett's fracture-dislocation in these four papers.

From the small numbers of clinical studies we jump to the large numbers of anthropometry, yielding evidence by strict statistical analysis. The present study of extension of the thumb may give results of great interest when it is extended downwards to the great toe; it is possible that Roberts' observation, that patients with hallux rigidus also have limitation of extension of the thumbs, may then gain statistical support.

The contribution on fractures of the scaphoid may remind some readers of the waning enthusiasm for bone grafting. Would it not be possible to trace a number of the many service cases so treated five or more years ago? Until this is done the prevalent subdued damnation of bone grafting, whether for reasons of expediency or for permanent benefit, must remain subdued.

The report on Léri's pleonosteosis points the way to further investigation of two painful syndromes of obscure etiology, namely, bilateral carpal tunnel compression of the median nerves and Morton's metatarsalgia. It may be that in both these conditions the primary abnormality is in ligaments, which were clearly the cause of median neuritis in this patient with pleonosteosis. But few surgeons resecting the plantar digital nerve bother to define either the degenerate vascular bundle or the foramen through which it runs, and those who use a dorsal excision cannot do so.

The contribution on Monteggia fractures may lead to consolidation of a number of scattered observations on the effects of rotation strain in the upper limb. For the benefit of those who did not hear this convincing paper when it was read to the British Orthopaedic Association the text has been illustrated very freely.

K. I. NISSEN.

GIANT-CELL TUMOUR OF BONE

In a recent number of the Journal we published a symposium on giant-cell tumour or osteoclastoma of bone, representing the views of many British pathologists and clinicians. No reader having studied the contributions and editorials would have been sure that a final and agreed opinion had yet been reached; and it was with little surprise that we received a spirited reply from Dr Lichtenstein. His observations, and the no less vigorous comment of Professor Dorothy Russell of London, are published in the correspondence columns.

EDITOR.

NATURAL HISTORY AND TREATMENT OF PULP SPACE INFECTION AND OSTEOMYELITIS OF THE TERMINAL PHALANX

HAROLD BOLTON, P. J. FOWLER and R. P. JEPSON, MANCHESTER, ENGLAND

From the Professorial Surgical Unit, The Manchester Royal Infirmary

Infection of the pulp space occurs with much greater frequency than more serious infections of the palmar space or tendon sheaths, and it may cause prolonged incapacity. There is often residual disability due to stiffness of joints, fibrosis of the tactile pad, or " minor causalgia " with a cold, blue, shiny and stiffened finger, aching pain of a " deep cold " quality and tactile hyperpathia. These cases are obviously important from a social and organisational standpoint. Statistics prepared for us by Professor R. A. Lane show that of all claims made under the Workmen's Compensation Act approximately 2½ to 5 per cent. were for septic hand lesions. Our own analysis of 1,979 patients seen in 1947 with hand infections indicates that 22 per cent. were pulp space infections, whereas only two cases were infections of tendon sheaths and five were infections of the palmar space (Table I).

TABLE I

ANALYSIS OF 1,979 NEW PATIENTS ATTENDING THE SEPTIC HAND CLINIC DURING 1947

	Percentage
Pulp space infections	22
Paronychia (acute and chronic)	26
Phalangeal infections	10
Web-space infections	11
Boils and carbuncles	4
Miscellaneous lesions: collar-stud abscess, lymphangitis, burns, septic lacerations, indelible pencil injuries, etc.	27
	Cases
Tendon sheath infections	2
Palmar space infections	5
Erysipeloid of Rosenbach	5

PATHOLOGY

The micro-organism concerned is usually the staphylococcus aureus (coagulase positive), but how it enters the pulp space is not always clear. In no more than half the patients is there a history of injury. Minor injuries are often overlooked or forgotten, but it may be that the staphylococcus enters by way of sweat or sebaceous glands (Cole and Elman 1948). Recent studies of the carriage of staphylococcus aureus in the skin and nose suggest that the skin of the hand may often be contaminated from the nasal vestibule by direct hand to nose contact (Moss *et al.* 1948).

The inflammatory reaction causes cellulitis which at first is confined by the tough fibrous septa that break up the pulp space into tiny compartments and are tightly adherent to skin and periosteum. It causes pain which is described as " tight " or " prickling." At this stage the infection may resolve spontaneously, particularly when chemotherapy has been used, but the number of such abortive cases is unknown because many never come to hospital.

If resolution does not occur, the formation of an abscess is accompanied by " throbbing " pain. At first the abscess is sharply limited by the fibrous trabeculae and it may be situated in any part of the pulp space (Hardman 1937). Thereafter it may spread in one of three directions: 1) through the periosteum into the terminal phalanx, or more seldom, around the side of the phalanx giving rise to an associated paronychia; 2) through the skin in front; 3) through the containing fibrous walls on its sides. The tissues which have least resistance to increasing tension, and to the locally produced necrotoxins, are the skin and periosteum: thus a superficial pulp abscess gives rise to a sinus in the skin, and a deep abscess destroys the periosteum and causes early osteomyelitis of the terminal phalanx. By the time the fibrous septa give way and a " total " pulp space abscess develops, osteomyelitis is already well established; there may also be a skin sinus. This conception is substantiated not only by clinical observation, which shows that a spontaneous skin sinus always overlies the localised pulp abscess, but also by radiographic examination, which demonstrates conclusively that the first evidence of erosion of the affected phalanx is directly opposite the abscess (Fig. 1). Thus in distal pulp space infection osteomyelitis begins at the tip of the phalanx; in lateral pulp space infection it begins on the corresponding side.

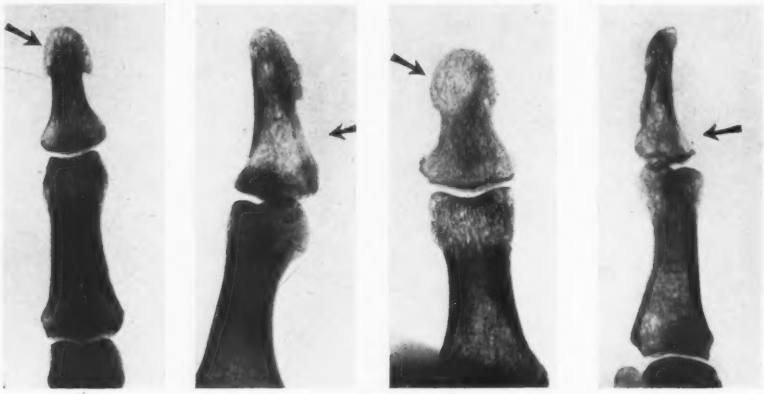

FIG. 1
Four examples of pulp space infection showing that bone erosion is always directly opposite the soft tissue abscess.

Hardman (1937) insisted that " the case must be treated before the onset of fluctuation, for at this stage the phalanx is dead." Iselin (1940) recognised that a spontaneous skin sinus was often associated with underlying osteomyelitis. This is always true if the abscess begins deeply in the space, but it is less constantly so in the case of more superficial lesions. That " pulp space " infection is not at first a generalised infection of the pulp but a localised and sharply delineated abscess involving only part of the pulp area can be demonstrated clearly at operation. The report of Iselin that " when incised it looks just like a boil with very little pus and ill-defined limits " is not in accord with our experience; such a description implies that the incision was made too early—that is to say, in the cellulitic stage.

If left untreated, pulp space infection follows a course that depends essentially on the location of the abscess. If it is superficial, a skin sinus develops before the periosteum or the fibrous walls are perforated, and by such drainage the infection may heal. On the other hand deeper and especially more distal abscesses, where there is less soft-tissue buttress between the skin and periosteum, do not heal readily after the development of a sinus; periosteal erosion has already occurred and the terminal phalanx is infected. It is in these cases that disability is prolonged, and it is important to separate them clinically from uncomplicated felons because rapid healing can be achieved only by early and intensive

penicillin therapy. Once the phalanx is infected the rapidity of development of osteitis, beginning at a point immediately opposite the site of maximal abscess tension, seems to depend on the virulence of the invading organism (Bolton, Catchpole and Jepson 1947). In some patients, particularly children, radiographic examination may show complete disappearance of the phalanx within a few days; in others bone erosion remains localised and the infection is quickly overcome. In general, abscesses that are situated proximally and first infect the base or waist of the phalanx destroy the bone more quickly than distal abscesses.

It is often said that occlusion or thrombosis of the digital arteries due to sustained compression in the inelastic pulp space by pressure of the abscess is an important cause of osteitis (Cole and Elman 1948), but we very much doubt whether this is true. The clinical sign of local heat suggests that the blood supply is increased, and if the pulp is incised without a tourniquet there is always free bleeding. If thrombosis were a common feature we should expect to find necrosis of the skin of the finger tip and ischaemic necrosis of the terminal

FIG. 2

FIG. 3

FIG. 4

The only example in the series in which there was radiographic evidence of ischaemic necrosis of the terminal phalanx. Radiographs on first attendance, six days after the onset of severe pulp space infection, showed no evidence of bone involvement (Fig. 2). After ten days, separation of a central slough exposed the necrotic terminal phalanx (Fig. 4). Radiographs showed relative density indicating avascular necrosis of the whole terminal phalanx (Fig. 3).

phalanx; radiography would show apparent density of the bone and not diffuse porosis or subtotal necrosis. In our study of 300 patients with pulp space infection such changes were seen in only one case (Figs. 2–4).

The degree of phalangeal reformation that may occur depends upon the extent of the bone lesion and the age of the patient (Fig. 5). When there has been complete destruction of the phalanx and its periosteum no regeneration can occur, but when destruction is less complete the whole phalanx may regenerate in young patients, though less complete replacement is to be expected in adults.

Occasionally infective arthritis of the terminal interphalangeal joint may develop by direct spread from a proximal abscess or from an area of osteitis. The flexor tendon sheath extends almost to the middle of the terminal phalanx and it may become infected in pulp space infections by the injudicious use of lateral drainage incisions; but we have not seen any case of tenosynovitis arising spontaneously. Probably the synovial sheath is obliterated by inflammatory reaction before bacterial invasion can occur.

TREATMENT

From the point of view of treatment, pulp space infections may be divided into three clinical groups: 1) simple felon; 2) suspected bony felon; 3) established bony felon (Bolton, Catchpole and Jepson 1947). *Simple felon* is a pulp space infection limited to the soft tissues; with correct treatment it heals without complication. *Suspected bony felon* is one in which it seems probable that there is osteitis because there is persistent sinus formation, continued pain, massive sloughing, or evidence at operation of periosteal damage; and yet radiographic confirmation is lacking. *Established bony felon* is one in which there is definite radiographic evidence of bone infection.

The conservative measures that are sometimes advocated can have little application to the treatment of patients who almost invariably have complained of pain for not less than four days before their first attendance at the clinic. In every case in this series without exception, pus was found in the pulp space when it was explored. The correct treatment for infection of the pulp space is incision and we believe that the only question to be determined is which incision is the best. For some time we have been dissatisfied with the lateral incisions that are used so generally. It is often found that a central pulp space abscess which has been opened widely by a J-shaped lateral incision, or bilateral straight incisions, continues to discharge through the overlying sinus, while the extensive lateral incisions close up and heal without serving any useful purpose after the initial evacuation of pus at the time of operation.

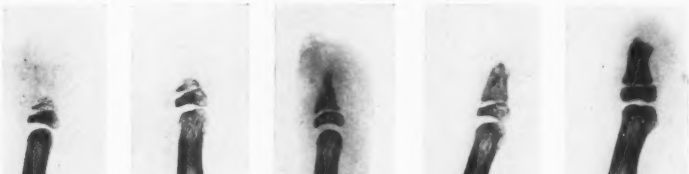

FIG. 5

Serial radiographs taken at four-week intervals in a child with pulp space infection, showing regeneration of the phalanx.

Study of the pathology of these lesions indicates that a *local* abscess should be drained through the skin immediately overlying it rather than by means of oblique incisions which traverse uninfected pulp tissue and are quickly narrowed by oedema. Moreover it is evident that "minor causalgia," which gives rise to lasting incapacity in about 2 per cent. of pulp space infections, is due to injury to the digital nerve caused by a lateral incision. Anatomical studies make it clear that with lateral incisions it is largely a matter of chance as to whether or not the digital nerve will be severed. On the other hand small incisions placed directly over the abscess will not damage the nerves which are displaced laterally.

Certain points in the technique are important. The site of greatest tension and tenderness should first be localised with precision by palpation with a blunt probe. Localisation is made easy if there is a spontaneous sinus because the sinus always lies directly over the abscess cavity (Fig. 6). Sometimes pus has extruded only through the true skin, lying imprisoned beneath unbroken squamous epithelium and thus forming a collar-stud abscess. General anaesthesia and a pneumatic tourniquet by which to secure a bloodless field are essential if the abscess is to be localised accurately. A small ellipse of cornified epithelium overlying the abscess is first excised (Fig. 7). The small sinus, which can then so often be demonstrated in the true skin, is excised elliptically over a length of four to five millimetres, the axis being transverse for central abscesses and longitudinal for lateral abscesses. The circumscribed

FIG. 6

FIG. 7

FIG. 8

FIG. 9

Central pulp space infection with threatened sinus formation (Fig. 6). An ellipse of skin was excised directly over the abscess which was traced down to intact periosteum (Figs. 7 and 8). One week later the incision was healed (Fig. 9).

abscess cavity, seldom measuring more than a few millimetres in diameter, is then revealed (Fig. 8). The cavity is filled with penicillin in lactose powder. No drainage is required because the cavity lies " saucerised " to the surface. The wound is dressed with broad-mesh vaseline gauze and an outer layer of dry gauze. In uncomplicated lesions two or three similar dressings at three-day intervals will suffice. The cavity quickly collapses and the incision heals in not more than ten or twelve days (Fig. 9). The scar is small and inconspicuous and the pulp is functionally unimpaired. Immobilisation of the digit is very occasionally needed because there is infective arthritis of an interphalangeal joint, or the whole limb may need to be immobilised because of lymphadenitis; but in all other cases active movements are encouraged at once.

RESULTS

Fifty unselected cases of pulp space infection have been studied. In every patient an abscess was found at operation, the situation being either superficial, deep, lateral or central. The results are shown in Table II. The healing time was calculated from the day of first attendance to the day of discharge from the clinic with a healed wound. The incidence in men and women was approximately the same. The thumb and index finger were the digits most commonly affected. Twenty-six patients attributed the lesion to a cut or injury. When bone infection was suspected or proved, penicillin was given intramuscularly in doses of

TABLE II

	Number of cases	Previous incisions	Site of pulp abscess				Average healing time
			Superficial	Deep	Lateral	Central	
Simple felon . . .	39	1	11	28	14	25	11·5 days
Suspected bony felon *	5	3		5	1	4	25 days
Established bony felon *	6	5		6		6	35 days

* Also treated by intramuscular injections of penicillin.

100,000 units twice daily for ten to fourteen days; in most of these patients there was some limitation of movement of the terminal interphalangeal joint at the time of discharge from the clinic. Only five patients in the whole series of fifty complained of a tender scar during the first few weeks after healing, and none developed causalgia.

DISCUSSION

In the management of pulp space infections it is first necessary to decide whether or not an incision is required. Some authors advocate "conservative" or "non-incisional" treatment of pulp space infections. It may be that their patients have been seen at an unusually early stage of the disease, before pus was localised, but for our part we would restate that every one of the fifty cases in this series had at the time of incision a localised collection of pus which clearly demanded evacuation. The second problem is to determine the best incision. We have abandoned lateral J incisions and bilateral linear incisions because they traverse uninfected tissue, fail to maintain drainage of the abscess, and may cause injury to the digital nerves with resulting causalgia. A small incision accurately localised over the site of the abscess accelerates the time of healing, minimises pain, oedema and discharge, avoids injury to the digital nerves and does not cause persisting tenderness even when the scar is in the tactile pad. Several of our patients were typists and despite the use of a central incision they resumed work within three weeks.

SUMMARY

The pathology of pulp space infection is discussed. It is recommended that a direct incision which is localised precisely to the abscess site, even if the incision is in the tactile pad, is better than a lateral incision, which fails to maintain drainage, causes longer incapacity, and may injure the digital nerve and give rise to causalgia. Fifty cases of pulp space infection in which a direct incision was used are reviewed.

Our thanks are due for the help and interest of Professor A. M. Boyd in whose department this work was carried out, to Dr Stewart Harrison for his suggestions, to Professor R. E. Lane for statistics, and to the Radiological, Pathological and Photographic Departments for technical aid.

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ANOMALOUS INNERVATION OF THE HAND MUSCLES

TOM ROWNTREE, LONDON, ENGLAND

From the Peripheral Nerve Injury Clinic, Royal National Orthopaedic Hospital

According to the usual text-book descriptions the median nerve supplies the abductor pollicis, opponens pollicis, flexor pollicis brevis and the two lateral lumbricals, while the ulnar nerve supplies all the other muscles in the hand (Gray 1946, Cunningham 1931, Wood Jones 1941). Several articles published since about 1890, notably in the French and the German literature, have mentioned variations found in anatomical dissections. The articles are remarkably contradictory. For example, Spourgitis (1895) stated that ulnar innervation of flexor pollicis brevis was very unusual—he had found it only once in all his dissections; whereas Riche (1897) considered it to be constant. Brooks (1886) drew attention to the existence of two heads of flexor pollicis brevis and found that their nerve supply varied. In dissections of thirty cadavers, flexor pollicis brevis was supplied by the ulnar nerve alone in five and by the median nerve alone in five; in nineteen the superficial head was supplied by the median nerve and the deep head by the ulnar nerve; in one the ulnar nerve supplied all the thenar muscles. Hovelacque reviewed the literature in 1927. He quoted Froment (1847) as stating that the median nerve constantly gave a branch to adductor pollicis; but Frohse and Fränkel (1908) found this in only 10 per cent., a figure with which Poirier (1901) agreed.

The first clinical study of the subject seems to be that by Highet (1943). In twenty patients with median nerve division, flexor pollicis brevis was paralysed in only four; in twenty-five with ulnar division only one showed any wasting of flexor pollicis brevis. The obvious explanation of these figures is dual innervation of this muscle. Highet's patients were the early ones in the Oxford series and are included in my analysis.

Murphey, Kirklin and Finlayson (1946) examined 698 ulnar nerve lesions and found that the first dorsal interosseous was innervated by the median nerve in four patients, in one of whom abductor digiti minimi was also supplied by the median. In all four patients the lesion was above the elbow; in two, blocking of the ulnar nerve at the wrist produced paralysis, suggesting an anastomosis from the median to the ulnar nerve in the forearm. In 551 median nerve injuries, opponens pollicis was found innervated by the ulnar nerve once only. These workers used exceptionally strict criteria for the activity of a given muscle, and in their large series there may have been other anomalous innervations which they did not accept.

Clinical material—I have studied the records of all the median and all the ulnar nerve lesions from Mr Seddon's clinic at both the Wingfield-Morris and the Royal National Orthopaedic Hospitals. There were 688 cases in the group, but many were unsuitable for inclusion in the analysis. The final number accepted was 226, namely 102 median and 124 ulnar nerve injuries. For a case to be accepted there had to be definite evidence of complete interruption of axonal continuity; either the nerve was seen to be divided at operation or, in certain lesions in continuity, direct electrical stimulation of the nerve exposed at operation failed to produce contraction in any muscle. Percutaneous stimulation was used to obtain corroborative but never absolute evidence of the distribution of a nerve. Incomplete lesions and lesions of both nerves were discarded. Throughout the series there has been a high standard of notation, but the statement " ulnar intrinsics paralysed " without any record of more detailed motor examination made it necessary for a few cases to be excluded. The findings in all the accepted cases may be regarded as accurate, for they were made by workers who were fully conversant with the pitfalls of clinical examination of individual muscles and with the trick movements described by Wood Jones (1919). The power of muscles was

assessed according to the Medical Research Council's 0–5 grading (1942). This system is reasonably accurate if there is one observer throughout, but some discrepancies occur, especially between 2 and 3, when assessments have been made by several clinicians. Therefore in this analysis 0 and 1 are classified as paralysed, 2 and 3 as weak, and 4 and 5 as fully active.

Apart from visual and electrical proof of injury to either nerve, additional evidence was obtained in some instances by means of blocking the intact nerve with procaine and then observing the resultant paralysis (Highet 1942). Unfortunately, this was not done in all patients with anomalous innervation owing to pressure of work at the time.

TABLE I

102 MEDIAN NERVE LESIONS

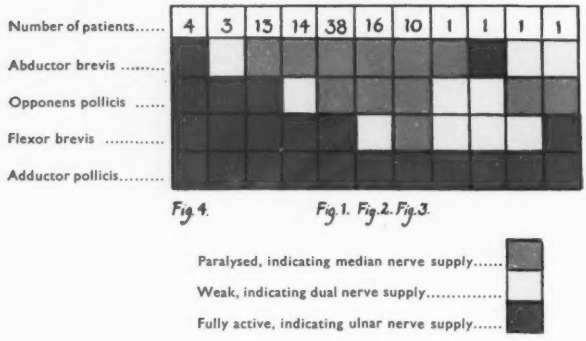
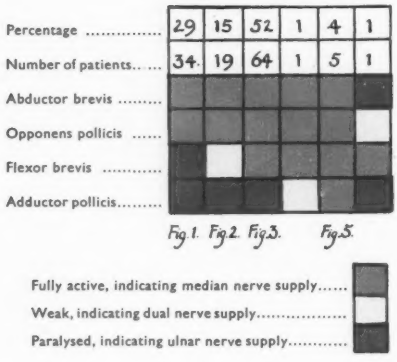


TABLE II

124 ULNAR NERVE LESIONS



Only the median and the ulnar nerves have been considered. There has been no certain evidence of innervation of any thenar muscles by the musculo-cutaneous or the radial nerves (Foerster 1929), although in one or two instances it was just possible. In this series, therefore, if after division of the median nerve a muscle in the hand was fully active, it was considered to be supplied by the ulnar nerve; if active but weak, it was considered to have had a dual innervation; if paralysed, it was of course supplied by the median nerve. No attempt has been made to differentiate between the two heads of flexor pollicis brevis, because clinically it is one muscle. The lumbricals have been ignored owing to the difficulty of testing them accurately.

Note—In all the figures and tables, colour indicates nerve supply and not voluntary power.

Analysis of findings—Tables I and II show the possible combinations of nerve supply. It is seen that the text-book description is the commonest arrangement, abductor pollicis brevis, opponens pollicis and flexor pollicis brevis being supplied by the median nerve and the others by the ulnar nerve. There is an inconsistency in the figures, however, for flexor pollicis brevis remained active in most of the median (73 per cent.) as well as in most of the ulnar injuries (58 per cent.). This, of course, is explained by the fact that flexor pollicis brevis usually has a dual supply and loss of one component may leave its power not appreciably altered.

FIG. 1

The pattern of innervation in 32 per cent. of cases. The flexor brevis pollicis was supplied by the ulnar nerve. See column 5 of Table I and column 1 of Table II.

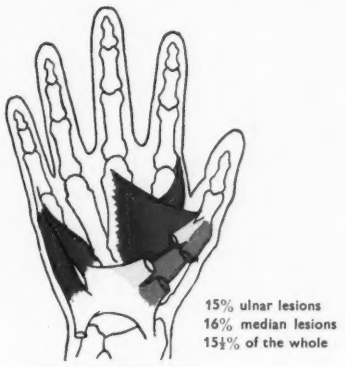


FIG. 2

The pattern of innervation in 15·5 per cent. of cases. The flexor brevis pollicis had a dual supply from both ulnar and median nerves. See column 6 of Table I and column 2 of Table II.

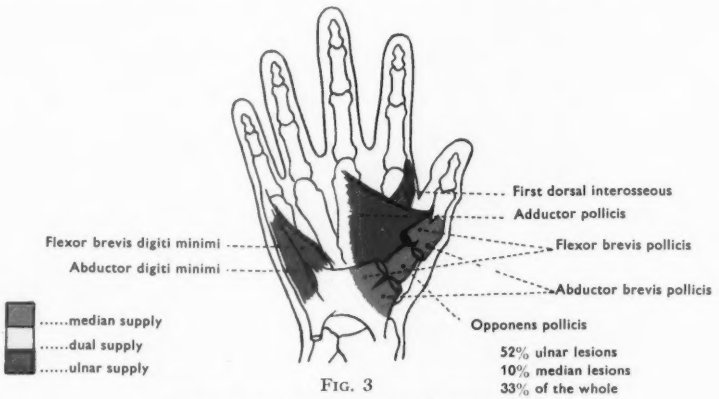


FIG. 3

The pattern of innervation in 33 per cent. of cases. The flexor brevis pollicis was supplied by the median nerve. See column 7 of Table I and column 3 of Table II. This is the standard text-book pattern.

Figures 1 to 3 show the common arrangements pictorially, with emphasis on the innervation of flexor pollicis brevis. Figure 1 shows the pattern in 29 per cent. of the ulnar lesions and in 38 per cent. of the median lesions, or in 32 per cent. of the whole. Figure 2 shows that there was clinical evidence of dual innervation of flexor pollicis brevis in 15 per cent. of the whole. Figure 3 represents the findings in 52 per cent. of the ulnar lesions and

in 10 per cent. of the median lesions, or in 33 per cent. of the whole. These three groups made 80 per cent. of the total.

It is significant that *one-fifth of all the cases studied had an anomalous nerve supply of some kind.* On referring back to Tables I and II, it is seen that six cases had an unusual innervation of abductor pollicis brevis alone. Of these six, in one (Table II, last column), we know that the ulnar nerve was responsible, for abductor pollicis brevis was paralysed after division of this nerve. In the other five, all median injuries (Table I, columns 1 and 9), it is not certain why abductor pollicis brevis remained active.

Apart from these cases, there is every gradation from *complete ulnar* to *complete median* innervation of the hand. Figure 4 shows one extreme in which all the muscles received ulnar innervation. This occurred in four patients, all with median lesions; to these may be added another three whose only motor loss was weakness of abductor pollicis brevis. Of the seven,

TABLE III

SIX ULNAR NERVE LESIONS

NAME	LEVEL	DORSAL INTEROSSEI				PALMAR INTEROSSEI			HYPO-THENAR
		1	2	3	4	1	2	3	
De J.	ELBOW					?	?	?	
D.	ELBOW								
H.	WRIST					?	?	?	
J.	WRIST								
R.	ELBOW								
T.	ELBOW								

Fig. 6

Fully active, indicating median nerve supply.....

Weak, indicating dual nerve supply.....

Paralysed, indicating ulnar nerve supply.....

Table III. This table gives further details of six cases in which the median supply exceeded that seen in the common patterns of Figures 1, 2 and 3. Five of the cases had the patterns shown in Figures 5 and 6, while the sixth, Case R., had dual innervation of adductor pollicis.

five had wrist-level lesions; in one patient procaine block of the ulnar nerve at the elbow produced complete paralysis of the hand. In these five there can have been no motor branch of the median nerve in the hand, except possibly to abductor pollicis brevis, and in the one just mentioned we know that there was no anastomosis across to the ulnar nerve in the forearm. In the remaining two cases in this group, the lesions were near the elbow and no procaine blocks were performed.

At the other end of the scale we have median innervation of each of the four thumb muscles (Fig. 5), with median innervation of one or more interossei in addition (Fig. 3). There were five such cases, with a sixth in which there was dual innervation of adductor pollicis and of several interossei (Case R).

Table III gives further details of these six cases. It will be seen that only two of the ulnar lesions were at the wrist, the other four being at the elbow. Case D had an injury of

the ulnar nerve at the elbow but no paralysis of the hand muscles. A median block at the elbow produced complete paralysis of the hand. Percutaneous stimulation of the ulnar nerve at the wrist, however, produced strong contraction of all the interossei. This suggested that the motor supply to the interossei travelled as far as the elbow in the median nerve and then

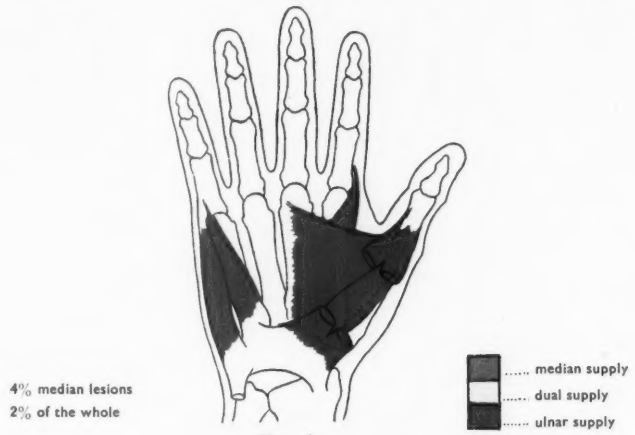


FIG. 4

The pattern of innervation in 2 per cent. of cases. All the thenar muscles were supplied by the ulnar nerve. See column 1 of Table I.

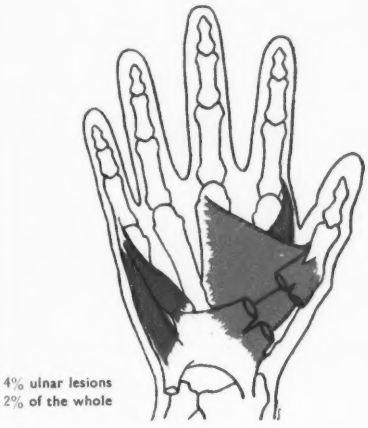


FIG. 5

The pattern of innervation in 2 per cent. of cases. All the thenar muscles, including adductor pollicis, were supplied by the median nerve. See column 5 of Table II.

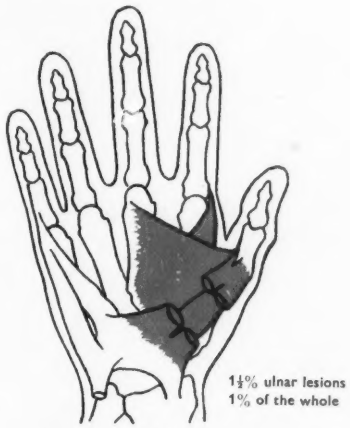


FIG. 6

The pattern of innervation in 1 per cent. of cases. All thenar muscles, including adductor pollicis, and the first dorsal interosseous were supplied by the median nerve. See column 1 of Table III, Cases de J. and D.

crossed over to the ulnar nerve in the forearm. In Case H the converse obtained. This patient had a low ulnar lesion, but electrical stimulation of the ulnar nerve at the elbow produced a good contraction in the hypothenar muscles, the first dorsal interosseous, the adductor pollicis and the palmar interossei, suggesting a free anastomosis from the ulnar to the median nerve in the forearm.

CONCLUSIONS

1. Voluntary activity of any given muscle in the hand is not an absolute indication of the state of the nerve which usually supplies it.
2. Significant variations in the standard pattern of innervation have been found in 20 per cent of 226 cases studied.
3. The pattern of innervation described in standard text-books occurred in only 33 per cent. of cases.
4. A striking variation is the supply of every thenar muscle by the ulnar nerve. In other cases the first dorsal interosseous muscle may be supplied by the median nerve.
5. In order to arrive at an accurate diagnosis when anomalous innervation is suspected, nerve blocks at appropriate levels are required.
6. Great care must be taken during operations to avoid damage to connections between the ulnar and the median nerves, especially in patients with anomalous innervation of the hand muscles.

I wish to pay tribute to all members, past and present, of the Peripheral Nerve Injury Units who have so accurately recorded their findings in the cases used in this analysis. I thank Mr H. J. Seddon for all his help and encouragement, and Miss Stanley for the drawings.

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INTER-METACARPAL BONE GRAFT FOR THENAR PARALYSIS

Technique and End-results

DONAL M. BROOKS, LONDON, ENGLAND

From the Institute of Orthopaedics, Royal National Orthopaedic Hospital

In 1930 Foerster described an operation for restoring opposition of the thumb in cases of paralysis of abductor brevis and opponens pollicis; a bone graft was inserted between the first two metacarpals to maintain the thumb in palmar abduction and opposition. The method was elaborated by Thompson (1942) and the results in seven cases were reviewed. Both authors were satisfied that the function of the hand was considerably improved. The alternative operation of fusing the trapezio-metacarpal joint was tried by Stiles and Forrester-Brown (1922), but they found, as did Lyle (1926), that the grip between the thumb and index was weak. That this is probably due to increased movement at the trapezio-carpal joint is substantiated by Müller (1949) who has found that a good range of movement of the thumb is retained after arthrodesis of the trapezio-metacarpal joint for osteoarthritis.

This paper is based on a review of sixteen cases in which bone graft operations were performed for thenar paralysis from peripheral nerve lesions. Some unexpected sequelae have been encountered and have led to certain modifications in technique.

Indications for operation—The sole indication for an opponens bone graft is permanent paralysis of the abductor brevis and opponens pollicis muscles for which tendon transplantation to restore active opposition cannot be performed. When flexor pollicis brevis and abductor pollicis *longus* are working strongly, control of the thumb is often good and no reconstructive operation is necessary. As Highet (1943) and Rowntree (1949) have shown, flexor brevis is often supplied by the ulnar nerve and may therefore be spared even in complete median palsy.

The employment of the tendon of flexor sublimis to the ring finger as a motor tendon for opposition of the thumb has become almost as reliable as tendon transplantation for radial palsy; flexor or extensor carpi ulnaris, though less satisfactory, can also be used (Bunnell 1948, Irwin 1942, Thompson 1922). A tendon for transplantation is not available when these three muscles are either paralysed or weak. Lack of independent movement of muscles that have recovered after suture of a main nerve is a well-known phenomenon. Thus, after high suture of the median nerve, even though flexor profundus and flexor sublimis digitorum may contract strongly together, there is loss of independent contraction of flexor sublimis—one of the special merits of this muscle. Furthermore, scarring about the wrist may make tendon transplantation impossible. Under such circumstances stabilisation of the first metacarpal bone in the best position is indicated.

Just as in tendon transplantation, any fixed adduction contracture, particularly of the skin, should be overcome before bone-grafting. If the deformity is secondary to shortening in the adductor pollicis muscle alone, it may be corrected either at operation or by means of preliminary stripping of the first metacarpal. The preliminary stripping was done in cases where there seemed to be some prospect of recovery in abductor pollicis brevis; in a few cases power returned soon after the over-stretching of the abductor had been corrected and there was then no need to proceed to the grafting operation. If the patient is in doubt about the benefit he will derive from the operation, trial plaster fixation of the thumb in the position of function will help him to make up his mind.

THE OPERATION

A graft from the subcutaneous border of the ulna is inlaid as a strut between the first and second metacarpals so as to control abduction and rotation of the first metacarpal with the thumb in the optimal position. A tibial graft was used on six occasions, but later the

ulna was found to be a better donor site and provided a graft of convenient size and shape which was used in a further nine cases. A segment of rib was satisfactorily employed once.

Technique—Two curved incisions are made over the first and second metacarpals so that the scars do not overlie the graft at any point (Fig. 1A). The shafts of the metacarpals are exposed subperiosteally, and if there is any contracture of the adductor pollicis the muscle is divided at its insertion and full passive correction obtained. The terminal part of the radial artery is not exposed deliberately nor indeed should it be seen. A narrow osteotome is passed across the space deep to the first dorsal interosseous muscle so that it lies over the middle of the shaft of each bone; the thumb is then placed in full palmar abduction and the length of graft required is noted.

The ulna is exposed subperiosteally through a three-inch vertical incision over the lower third of the subcutaneous border and a graft of the required length is cut with a motor saw. This gives a piece of bone that is D-shaped in cross-section and rather more than a centimetre in width. The incision is then closed.

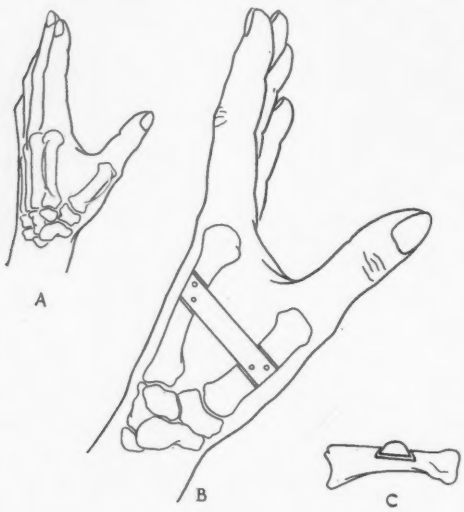


FIG. 1

Details of operation, showing the curved incisions (A), the graft in position with drill-holes ready for sutures (B), and the cross-section of graft and undercut edges of the bed (C).

The graft is passed across the interspace and, with the thumb in full abduction and rotation, the lines of bone resection are marked on the metacarpals, with particular attention to obtaining maximal rotation of the first. Saw cuts are then made so that the edges of each bed are slightly undercut (Fig. 1C); steps about half the diameter of each bone are removed. It is important to ensure that the beds for the graft are in the same plane when the thumb is in full opposition.

The graft is then driven in from one end; because of the shape of its cross-section it is held snugly in the slots and rotation is controlled at once. Two drill-holes are made through the graft and metacarpal at each end and chromic catgut sutures are inserted to maintain full abduction (Fig. 1B). The ends of the graft are trimmed to leave no rough surfaces. When subluxation of the trapezio-metacarpal joint is present, as may occur in young patients after poliomyelitis, the joint may be excised.

Closure is effected by skin sutures only, and a plaster-of-Paris cast is applied. Three weeks later the stitches are removed and a closely fitting plaster is applied for a further period of ten weeks, making three months in all.

DISCUSSION OF RESULTS

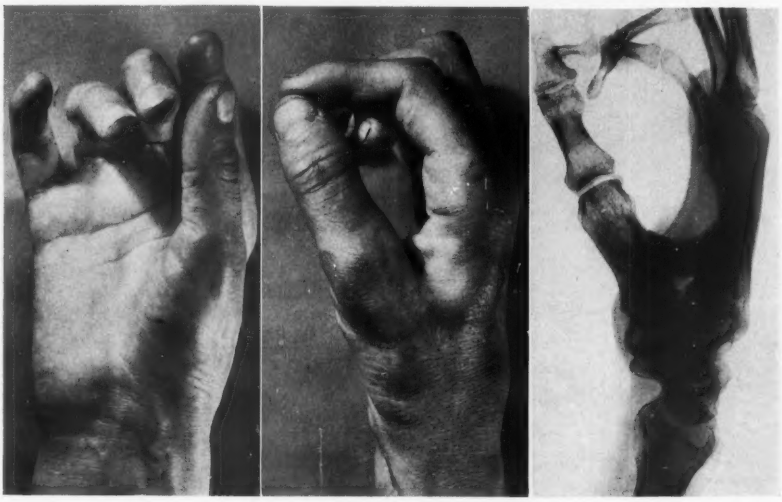
The operation has been performed in sixteen cases. In five the result was an unqualified success (Figs. 2 and 3); in a further nine, despite some imperfections, the function of the hand was considerably improved. The other two cases were failures.

Causes of failure and poor results—These were: 1) failure of fusion; 2) sepsis; 3) failure to achieve full opposition; 4) combined paralysis of the first dorsal interosseous and lumbrical muscles; and 5) " pollex valgus."

A B C

FIG. 2

Case M96. Note the good abduction and rotation of the thumb and the normal opposition of the terminal phalanges.



A B C

FIG. 3

Case G34. Showing a good result despite partial sequestration of the graft.

A B C

FIG. 4

Case M84. Pseudarthrosis at the second metacarpal end of the graft, but a useful range of active opposition. Note the secondary rotation arthrodesis of the metacarpo-phalangeal joint of the thumb.

A B C

FIG. 5

Case S104. To show the acquired deformity of "pollex valgus" following an opponens bone graft. Note the incomplete rotation of the first metacarpal (A) and the degree of passive correction allowed (B). In the relaxed position (A) the tendon of extensor longus pollicis is displaced to the ulnar side like the tendon of extensor longus hallucis in hallux valgus.

) *Failure of fusion*—Five grafts failed to fuse at one or other end but never at both. In two of these cases absorption of the graft allowed the adduction deformity to recur and there was evidence to suggest that inadequate fixation after operation was the cause. Where there was failure of fusion to the second metacarpal the disability was surprisingly slight; by using the long extensor and flexor tendons of the thumb alternately, the patient gained a range of movement through an arc the centre of which was the pseudarthrosis (Fig. 4). Foerster had a similar experience and regarded pseudarthrosis at one end as a positive advantage.

) *Sepsis*—Sepsis occurred in three cases where the skin incision overlaid the graft, but with curved incisions this complication has not been seen. In one case a sequestrum consisting of most of the graft was removed, but in spite of this a firm bony strut was formed (Fig. 3C).

) *Failure to achieve full opposition*—In five cases, although the thumb became fixed in full palmar abduction, rotation of the first metacarpal into full opposition was not maintained;

FIG. 6

Case G41. In addition to the thenar paralysis there was complete intrinsic paralysis of the index finger; arthrodesis of the proximal interphalangeal joint has been performed.

FIG. 7

Case R63. Another case showing incomplete rotation of the first metacarpal and "pollex valgus."

thus the pad of the thumb met the *side* of the distal phalanx of the index and gave a weak grip. In one case arthrodesis of the metacarpo-phalangeal joint of the thumb in slight flexion and correct rotation was subsequently performed (Fig. 4C). In another case a fracture of the first metacarpal occurred at the site of inlay during operation, and the opportunity to perform a rotation osteotomy was accepted with success.

) *Combined paralysis of the first dorsal interosseous and lumbrical muscles*—With a thenar paralysis, although the thumb lies in the plane of the palm, there is a strong grip between the pad of the thumb and the side of the second metacarpo-phalangeal joint. In such a case, if the thumb is maintained in full abduction without full rotation the grip is transferred distally so that the side of the thumb and the side of the distal phalanx of the index meet. Usually this is not a great disability; but if the first dorsal interosseous and lumbrical are

TABLE I.—Inter-metacarpal Bone Graft for Thenar Paralysis

Case No.	Nerve lesion	Associated deformities	Time after injury (months)	Donor site of graft	Duration of immobilsation (months)	Further operations	Duration of observation (years)	Result
A51	Brachial plexus, traction lesion	None	33	Ulna	5	None	3	Fair. Incomplete rotation
B85	Median and ulnar, gun-shot wound	None	30	Tibia	3	None	4	Fair. Absorption of graft, poor abduction
B66	Median, gun-shot wound	Multiple scars in vicinity of first cleft	29	Tibia	4	None	5	Fair. Incomplete rotation
C127	Median and ulnar, gun-shot wound	No passive opposition. Preliminary stripping of first metacarpal	16	Tibia	1½	None	4	Poor. Absorption of graft, adduction recurred
G41	Median and ulnar, gun-shot wound	None	20	Rib	3	Arthrodesis of proximal interphalangeal joint of index	4	Good
G34	Median and ulnar, gun-shot wound	None	46	Ulna	4	Sequestrectomy	3	Good
M96	Median and ulnar, gun-shot wound	None	8	Tibia	3	None	5	Good
M84	Median and ulnar, laceration	None	26	Ulna	4	Rotation arthrodesis of metacarpo-phalangeal joint of thumb	3	Good. Pseudarthrosis at second metacarpal
M61	Brachial plexus, traction lesion	None	52	Ulna	5	None	3	Good
N41	Median and ulnar, gun-shot wound	None	15	Ulna	4	None	3	Good. Pseudarthrosis at second metacarpal
R63	Median, gun-shot wound	None	7	Tibia	6	None	4	Fair. Incomplete rotation, "pollex valgus"
R26	Median and ulnar, gun-shot wound	No passive opposition. Preliminary stripping of first metacarpal	36	Tibia	5	Sequestrectomy	5	Fair. Pseudarthrosis at first metacarpal
S104	Brachial plexus, gun-shot wound	None	36	Ulna	4	None	3	Fair. Incomplete rotation, "pollex valgus"
W104	Median and ulnar, gun-shot wound	Marked contracture of skin in first cleft	22	Ulna	5	Plastic turntable flap at time of operation	4	Good
W141a	Brachial plexus, traction lesion	None	54	Ulna	3	None	3	Fair. Incomplete rotation

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paralysed the grip is weakened considerably since radial stabilisation of the index finger is impossible. Furthermore, if full abduction and opposition are achieved by means of a bone graft and there is simultaneous paralysis of the first dorsal interosseous and lumbrical muscles, the tip of the index may fail to reach the pad of the thumb, because the long flexors, acting alone, cause the finger to fold up. This disability was overcome in one case by performing arthrodesis of the proximal interphalangeal joint of the index in about 35 degrees of flexion (Fig. 6).

5) "*Pollex valgus*"—This acquired deformity has been seen twice (Fig. 5). It may have been due to paralysis of abductor pollicis brevis; on the other hand both these cases showed incomplete rotation of the first metacarpal (Fig. 7) with ulnar displacement of the tendon of extensor pollicis longus; and it seems more probable that this is the important etiological factor. The disability from such a deformity is more apparent than real because the abducted position of the first metacarpal permits a useful grasp even though opposition is defective.

SUMMARY AND CONCLUSIONS

1. Sixteen cases of thenar paralysis are reviewed in which a bone graft was inserted between the first and second metacarpals to maintain fixed abduction and opposition of the thumb.

2. The technique of the operation is described and the causes of failure are discussed.

3. The operation is intended for those cases in which tendon transplantation to restore active opposition of the thumb is unsuitable. Rotation of the first metacarpal into full opposition is the most important feature of the operation.

I am most grateful to Mr H. J. Seddon for his helpful criticism; to the staff of the Photographic Department of the Institute for the clinical photographs; and to Miss Diana Stanley for the drawings.

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THE RESULTS OF TREATMENT IN KIENBÖCK'S DISEASE

ALFORD DORNAN, SHEFFIELD, ENGLAND

Kienböck's disease is not common but it occurs sufficiently often to be of orthopaedic importance. The treatment and the prognosis are particularly important because most of the cases occur in heavy workers. For this reason it is of interest to review the results of treatment in a series of patients from an industrial area.

The condition was recognised by various observers before 1910, but it was Kienböck who first made a thorough study of the subject and tried to correlate the radiographic findings with the various clinical phases. He held that the condition was a malacia of the lunate bone from interference with the blood supply through the ligaments. This he attributed to injury which could be caused by a momentary subluxation of the bone (" jump subluxation "). Such fractures as might occur he regarded as secondary.

Persson (1945) agreed with the view originally advanced by Hultén (1928) that an important etiological factor is relative shortening of the lower end of the ulna with increased prominence of the articular surface of the radius, so that the lunate bone is exposed to greater stress in compression injuries of the wrist. This anatomical state, which Persson termed the " minus variation," was found in 8 per cent. of the general population, but in as many as ten of his nineteen cases of Kienböck's disease. This variation was present in a much smaller proportion of our cases. Persson advocated lengthening the ulna and reported good results. He believed that the operation relieved mechanical stress and so enabled the lunate bone to regenerate.

The condition has also been considered due to primary fractures, aseptic emboli and osteitis, but is now generally ascribed to avascular necrosis from traumatic interference with the blood supply.

TABLE I

CASES ACCORDING TO AGE GROUPS

Age in years	Cases	No operation	Operation
10 – 19	5	3	2
20 – 29	14	3	11
30 – 39	13	11	2
40 – 49	9	8	1
50 and over	2	2	0
Total	43	27 (63%)	16 (37%)

For the purpose of this paper a review has been made of the patients with Kienböck's disease under my care in the past ten years. In all there were forty-six: three, treated conservatively, could not be traced; forty-two were seen and examined; the remaining patient failed to attend but the result was assessed from hospital records. Of the forty-three traced patients forty were male and three female; thirty-eight were heavy workers, including twenty-five coal-face workers, and five were light workers, including one housewife. The right wrist was affected in twenty-four cases and the left wrist in nineteen. Twenty-seven patients were treated conservatively. Of these, twenty-two were treated by immobilisation for an average period of three to four months; two were treated by rest and physiotherapy; and three had no specific treatment except a period of rest from work. Sixteen patients were treated by excision of the lunate bone, six as a primary measure and ten after a period of

conservative treatment had failed to give relief. One patient was treated by arthrodesis of the wrist after an unsatisfactory result from excision.

Operation—The usual posterior approach was used, with a longitudinal incision, division of the sheath of extensor digitorum communis, and displacement of the tendons. Care was taken to make the excision complete, with the least possible injury to the other carpal bones. This was facilitated by continuous traction on the hand by an assistant. No post-operative immobilisation was used, movements of the fingers being encouraged from the beginning and wrist movements after a few days.

Results were classified as: *excellent*, no complaints and capable of full work without difficulty; *good*, capable of full work without loss of time, but symptoms after very heavy use; *fair*, improvement in symptoms but unable to resume heavy work; *poor*, no improvement, with persistent weakness and pain in the wrist.

It was found that the quality of the functional result was not always directly proportional to the final range of movement. Freedom from pain on movement, especially forced movement, and strength of grip were more important criteria of a good functional result. There was usually some weakness of grip, but in cases described as excellent this was slight.

Table II shows that of the patients who were traced 63 per cent. returned to full work after conservative treatment. In this group the three patients receiving no specific treatment had good or excellent results. Of the two treated by physiotherapy alone, one had a good and the other a fair result.

TABLE II

ANALYSIS OF RESULTS OF CONSERVATIVE TREATMENT

Age in years	Excellent	Good	Fair	Poor	Total
10 – 19	0	3	0	0	3
20 – 29	1	0	1	1	3
30 – 39	5	2	3	1	11
40 – 49	3	3	2	0	8
50 and over	0	0	1	1	2
Total	9 (33%)	8 (30%)	7 (26%)	3 (11%)	27

TABLE III

ANALYSIS OF RESULTS OF EXCISION

Years after operation	Excellent	Good	Fair	Poor	Total
4 – 6	3	1	2	1	7
2 – 4	1	2	0	0	3
1 – 2	2	0	2	0	4
0 – 1	1	1	0	0	2
Total	7 (44%)	4 (25%)	4 (25%)	1 (6%)	16

Table III shows that 69 per cent. of patients returned to full work after excision of the lunate bone. One patient with a poor result was treated subsequently by arthrodesis of the wrist over two years ago; this gave considerable improvement, but he has not resumed his full pre-accident work as a steel worker. The result in the patient assessed from hospital notes is recorded as " fair " in the top line.

In attempting to compare the results of excision with those of conservative treatment it is difficult to select comparable groups because of the uncertain duration of the pathological process in a high percentage of cases, for instance those with obviously long-standing radiographic changes but with only a recent history of injury. Since excision of the lunate bone

was not advised in elderly patients, or in the presence of gross arthritic changes, the choice of operation was virtually limited to patients under forty years of age. It was thought that the group of patients under the age of forty years who were treated conservatively was on the whole comparable with the group in which excision was undertaken. Reference to Table II shows that the results of conservative treatment in this age group differs little from the results in the whole series, 65 per cent. returning to full work.

DISCUSSION

This series of cases was drawn mostly from a mining community. The prognosis appears on the whole better than is usually supposed, because a fairly high proportion of patients returned to heavy work after either conservative or operative treatment. In fairly comparable groups the results of treatment whether by conservative measures or by removal of the lunate bone were not strikingly different.

In most patients treated conservatively with success the period of fixation was not long and only two patients required more than three months. Often the length of the history or the radiographic appearances showed that the condition had been latent for a long time and had been revealed only by a recent injury causing definite symptoms. In such cases a period of rest has been sufficient to restore quiescence and satisfactory function and to allow return to heavy work for a number of years. This seems to indicate a period of immobilisation for all patients, unless there are special reasons for primary excision of the lunate bone.

Arthrodesis of the wrist is valuable as a last resort, when there is persistent pain with gross osteoarthritis of the carpal joints. It does not, however, restore efficiency for many of the heavier types of work.

Has excision of the lunate bone a place in treatment? In those cases treated successfully by removal of the lunate bone, a striking result was the frequency of relief from aching pain. The strength of grip, although usually diminished just after the operation, gradually returned, though in some cases only after many months. None of the cases regarded as satisfactory has deteriorated. In my opinion removal of the lunate bone is justified in the few cases where there is no gross osteoarthritis, and where aching pain persists after efficient immobilisation for three or four months.

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A CASE OF RUPTURE OF FLEXOR TENDONS SECONDARY TO KIENBÖCK'S DISEASE

J. I. P. JAMES, LONDON, ENGLAND

From the Institute of Orthopaedics, Royal National Orthopaedic Hospital

Pathological rupture of the flexor tendons at the wrist is uncommon. Colles fractures probably account for most cases; displaced fragments may cause attrition, or secondary arthritis may lead to degenerative changes in the related tendons and tendon sheaths (McMaster 1932). The case reported here of an unusual cause of rupture may be of some interest.

Case history—F. R., aged fifty years, a motor driver, attended the Hand Clinic at the Royal National Orthopaedic Hospital complaining of aching pain in front of the left wrist of nine years' duration. In the first place the hand and fingers became swollen for one day

FIG. 1

Pre-operative photograph showing limitation of active flexion of the thumb and index finger.

FIG. 2

To show the improvement in active flexion of the thumb and index finger six months after operation.

and he stayed away from work for two days; there was no history of injury. Four months before reporting he found that he was unable to flex the distal joint of the index finger. This loss of power happened for no apparent reason and without pain. Three months later, though he was not using his hand, it suddenly became cramped and assumed the obstetric position. There was severe pain, and when this and the cramp subsided he was unable to flex the interphalangeal joint of the thumb.

When he was examined one month later, a soft tissue swelling was visible in front of the wrist, and proximal to this, some hollowing of the radial half of the anterior surface of the forearm. He could not flex the distal joint of the thumb or of the index finger (Fig. 1). Dorsiflexion and radial abduction of the wrist joint were limited by approximately one-third. There was no loss of sensation in the hand and no wasting of the thenar muscles.

Radiographs of the wrist revealed longstanding Kienböck's disease of the semilunar bone which was dense and much compressed. In the lateral view several loose fragments could be seen in front of the proximal row of the carpus (Fig. 3).

Treatment—The flexor tendons were exposed at the wrist and the transverse carpal ligament was divided. The median nerve was normal. The tendons of flexor pollicis longus and flexor

FIG. 3
Radiographs of the wrist showing the dense fragmented semilunar bone.

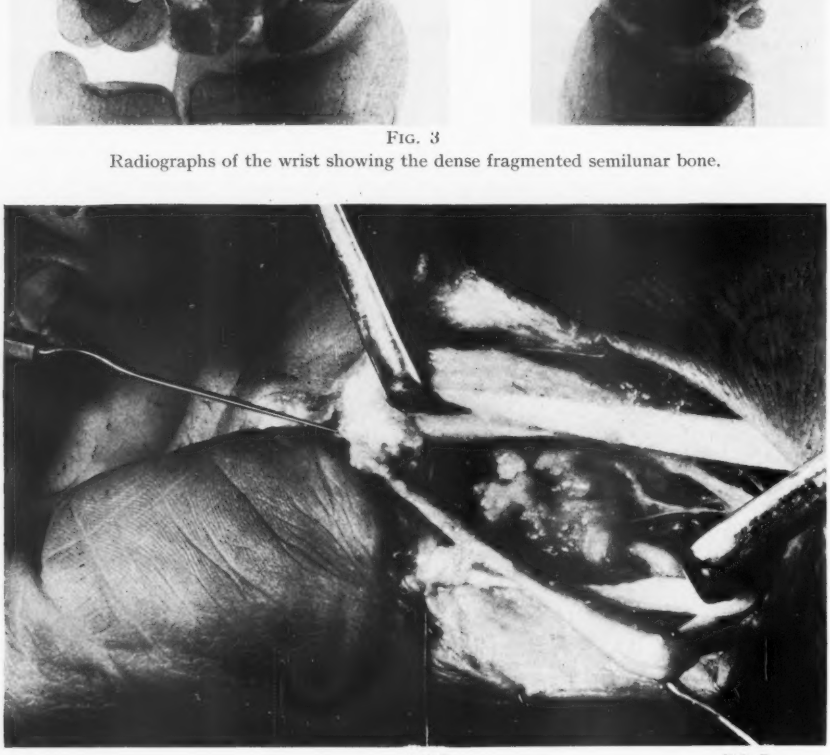

FIG. 4. Showing ruptured and frayed tendons. F.D.P.—flexor profundus to the index finger in continuity with its empty tendon sheath. F.P.L.—flexor pollicis longus similarly affected. F.D.S.—flexor sublimis to the index finger severely frayed. The aperture in the capsule can be seen in the angle between flexor profundus and flexor sublimis.

FIG. 5
The fragments of semilunar bone.

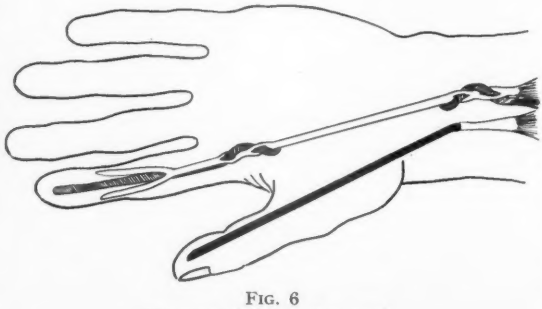

FIG. 6
The plan of the tendon repair.

profundus to the index finger were found to be completely divided and separated by a gap of two and a half inches, across which ran the empty tendon sheaths (Fig. 4). The ends of each tendon had rounded off smoothly and there was no fraying. The adjacent tendons of flexor sublimis to the index and of flexor profundus to the middle finger were, however, grossly frayed like ropes worn half through. On exposure of the anterior capsule of the wrist an aperture was found leading to the affected semilunar; with flexion of the joint three small loose bodies were extruded (Fig. 5). The semilunar was excised, a dorsal incision being required for one mobile fragment.

Repair of the tendons was then effected (Fig. 6). The distal part of the tendon of flexor pollicis longus was resected. A long free graft from the extensor tendon of the third toe was then sutured in position by the Bunnell technique. The graft lay between the proximal end of the ruptured tendon and the insertion of flexor pollicis longus into the distal phalanx. Both proximal and distal ends of the profundus tendon to the index finger were sutured to the corresponding sublimis tendon with the finger in flexion. A plaster cast was applied with the thumb, index finger and wrist flexed and was retained for four weeks.

The post-operative recovery was uneventful. Six months after operation there were 10 degrees of active flexion of the distal joint of the index finger and the finger was no longer hyperextended when at rest. Active flexion of the interphalangeal joint of the thumb was strong through 15 degrees (Fig. 2). The patient found little disability in either digit and the wrist was painless.

Comment—The damaged flexor tendons are anatomically those most closely related to the semilunar. It is surmised that during flexion and extension of the wrist these tendons were pulled taut across the displaced fragments. No similar case has been discovered in an extensive search of the literature.

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INTER-CARPAL DISLOCATIONS AND FRACTURE-DISLOCATIONS

A Review of Fifty-nine Cases

T. B. RUSSELL, GLASGOW, SCOTLAND

From the Fracture and Orthopaedic Service of the Royal Air Force and from the Victoria Infirmary, Glasgow

Most of the patients in this series were treated at some stage in Royal Air Force Hospitals during the recent war. About a quarter of the total were seen or treated personally, the remainder being assessed by examination of their case-records and radiographs. Probably all except one of these patients sustained their injuries as a result of forcible dorsiflexion of the wrist joint, but the exact mechanism of injury could seldom be determined. It should be emphasized that almost all the results are early; a late follow-up of the Service cases has not been possible. The results have been assessed for convenience as "good"—a painless wrist with an adequate range of movement; "fair"—slight pain and stiffness insufficient to interfere with most normal activities; and "poor"—a painful, weak or very stiff wrist.

It will be seen that although anterior dislocations of the lunate bone are generally considered to be the most common type of inter-carpal dislocation, trans-scapho-perilunar dislocations outnumber them in this series by almost two to one. It is possible, however, that dislocations of the lunate were more often treated in general surgical units and not referred to orthopaedic departments. Otherwise the series probably gives a reasonably accurate indication of the relative incidence of the various injuries.

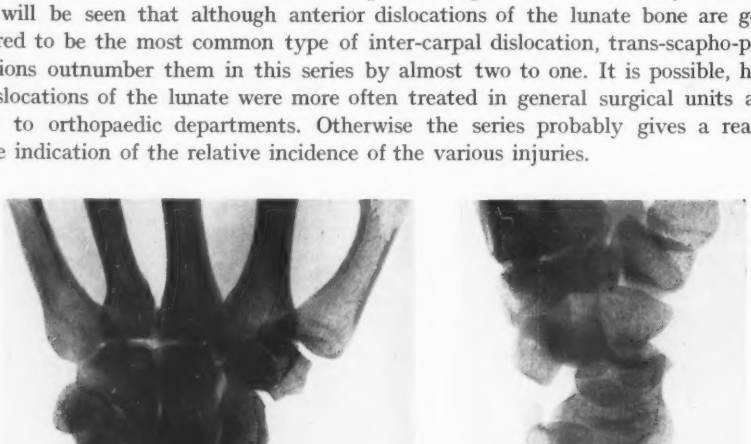

FIG. 1

The radiographs of a case of trans-scapho-perilunar fracture-dislocation. Satisfactory reduction was obtained and four months later the scaphoid was uniting.

TRANS-SCAPHO-PERILUNAR FRACTURE-DISLOCATION—TWENTY-SEVEN CASES

This injury is not a common one and the radiographs may be misinterpreted (Fig. 1); thus nine cases had been labelled "dislocated lunate," "fractured scaphoid" or "congenital abnormality of the carpus."

Clinical features—Before it is obscured by marked swelling, backward displacement with increased antero-posterior thickness about the mid-carpal level is apparent, and the proximal margin of the capitate may be palpable on the dorsum. Radial deviation of the hand is usually present together with painful restriction of wrist and finger movements.

Associated injuries—The ligamentous injury is inevitably severe and chip fractures, damage to articular surfaces and fractures of the styloid processes are common. Thus one or both styloid processes were fractured in ten of the cases, the capitate twice, and the triquetrum, pisiform and fourth metacarpal in single instances.

Complications—Avascular necrosis of the proximal scaphoid fragment occurred in thirteen or approximately half the cases. Transient median nerve paralysis was noted only twice.

Treatment—" Early " cases seen within fourteen days of injury could usually be reduced by closed manipulation; with steady manual traction, the wrist was gradually brought into flexion and slight ulnar deviation and a forearm plaster including the proximal joint of the thumb was applied. Twenty patients were seen early; closed reduction was obtained in all, although in three a slight rotational subluxation or lack of complete apposition between the scaphoid fragments persisted. Two cases were successfully reduced eleven and twelve days after injury. It is sometimes advised that the wrist be immobilised in the neutral position after the first week; but in two cases dorsal subluxation tended to recur, and it would seem wise to maintain palmar flexion for three weeks after reduction.

Treatment of the "late" case—Closed reduction failed in two "late" cases seen three weeks after injury, and attempts at closed reduction after this period may cause more damage to the wrist than careful open reduction. Open reduction was performed in two cases, four and six weeks after injury. When more than six weeks had elapsed without reduction, and the wrist remained painful after a fair trial, arthrodesis of the wrist joint was advised.

Treatment of avascular necrosis—Three different lines of treatment were adopted when the diagnosis of avascularity of the proximal scaphoid fragment was made: bone grafting, three cases; excision of the avascular fragment, four; and continued immobilisation, five. When excision was carried out, the operation was performed as soon as the diagnosis was made, normally six or eight weeks after injury, and immobilisation was continued for a further two or three weeks. It is to be noted, however, that early excision of a large scaphoid fragment in the presence of a lax ulnar collateral ligament jeopardises the stability of the wrist. In this small series the results of excision and of continued immobilisation were approximately equal; grafting was disappointing.

Results—(i) *Closed reduction and immobilisation only*—Eleven cases. The average period of immobilisation was almost five and a half months. Sound bony union of the scaphoid occurred in four cases, all with a good result; in one of these avascularity of the proximal fragment had been noted. In five cases it was thought probable that bony union had occurred, despite an avascular fragment in one case; one result was good, one fair, and three were not recorded. In two cases with avascular necrosis non-union was accepted after five and seven months of immobilisation; the functional result, however, was good in one patient who returned to duty as a pilot and fair in the other.

(ii) *Closed reduction followed by excision of an avascular scaphoid fragment*—Four cases. One was a failure and the wrist was arthrodesed nine months later; another had a fair result in spite of radial deviation of the hand; in the remaining two the results were good.

(iii) *Closed reduction followed by scaphoid grafting or simple drilling*—Five cases. Four patients had a cortical peg graft inserted into the scaphoid by the " closed " or " blind " method; two already had an avascular proximal fragment, and one grafted four weeks after injury later showed radiographic evidence of avascularity. In one the scaphoid failed to unite and the result was poor. In the other three, union was obtained; the functional result remained poor in two but promised well at six months in the third. In one patient simple drilling of the scaphoid was performed eleven weeks after injury; union was not sound five months after operation.

(iv) *Open reduction*—Two cases. This was performed twice, four and six weeks after injury. In the first case, despite an avascular fragment, the scaphoid united after seven months immobilisation. The patient was last seen only two weeks later but was then moving his wrist well. In the second case the proximal part of the scaphoid was removed at the time of operation because it was thought certain that its blood supply had been impaired; the functional result was good.

(v) *Late unreduced cases*—Five cases. These were seen at periods from three weeks to seven months after injury. Three had successful arthrodesis of the wrist and another was thought likely to require arthrodesis. The fifth had a weak and stiff but painless wrist nine months after injury, with some crepitus in the sheaths of the flexor tendons to the fingers.

DISLOCATION OF LUNATE—FOURTEEN CASES

All cases showed anterior displacement (Fig. 2). In two instances the original radiographs had been reported as normal, thus accounting for some delay in treatment.

Clinical features—Wrist movements were limited and the fingers were held in semiflexion; tingling, numbness or pain in the median nerve distribution were common. The displaced lunate was sometimes felt as a prominence on the anterior aspect of the wrist, with a corresponding depression on the dorsal aspect.

Associated injuries—The lunate bone itself, the triquetrum and the capitate were each fractured in single instances.

Complications—A transient median palsy was recorded in four cases and in one patient persisted for more than three months. Vascular changes in the bone were notable for their absence. Only one lunate showed increased relative density but with no evidence of collapse or necrosis; after three previous attempts at reduction the dislocation had been reduced by skeletal traction seventeen days after injury, by which time skin ulceration had developed in front of the wrist. The radiographic appearances in this case did not resemble Kienböck's disease. MacAusland (1944) found no record of Kienböck's disease after dislocation of the lunate, even with open reduction. It seems unlikely therefore that this "disease" can result from a single injury of the type that causes dislocation of the lunate, in which some blood supply to the bone is usually preserved through the intact palmar radio-carpal ligament.

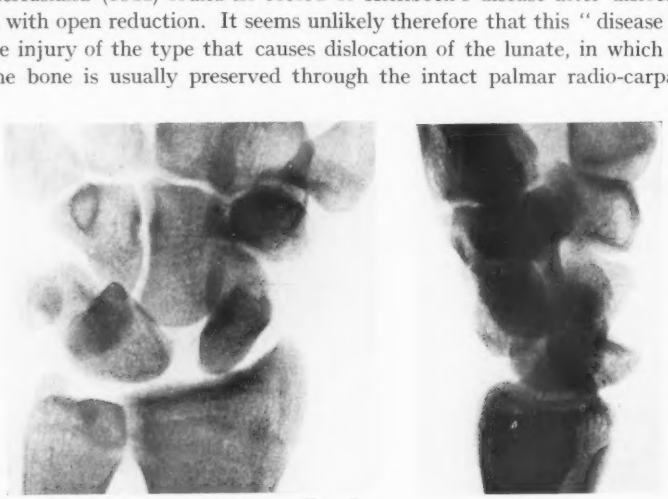

FIG. 2
Typical radiographs of anterior dislocation of the lunate.

Treatment—In cases seen within ten days of injury, reduction by traction and direct digital pressure on the displaced lunate was usually accomplished quite easily. The wrist was immobilised in palmar flexion for about a week and in the neutral position for a further two weeks.

Of nine "early" dislocations eight were reduced in this way; one, though seen within two days, required the use of a distraction frame with Kirschner wires through the olecranon and the necks of the metacarpals.

Five patients were seen "late" with unreduced dislocations at intervals varying from two weeks to three months after injury. One was reduced on a distraction frame at seventeen days, and the remaining four had the lunate excised by the anterior approach. Operative reduction was not attempted in any case.

Results—Of the ten patients whose dislocations were reduced, six had a good result; one patient with almost full movement still complained of pain six months after injury and was therefore classified as fair; in two the injury was too recent for assessment but progress was satisfactory.

The patient whose dislocation was reduced by skeletal traction seventeen days after injury had a poor result. After eighteen months he had rather a stiff wrist with discomfort in cold weather and there was still some radiographic evidence of bone atrophy.

The results in the four cases of excision were satisfactory, all the patients having a good grip, a painless wrist and adequate movement, except for some limitation of palmar flexion.

FORWARD DISLOCATION OF LUNATE AND HALF OF SCAPHOID—SIX CASES

Certainly in its clinical features, and probably in the mechanism of its production, this injury is similar to simple anterior dislocation of the lunate. In five cases the proximal fragment of the scaphoid dislocated forwards with the lunate as usual, but the *distal* fragment was displaced with the lunate in one case.

Associated injuries—The triquetrum was fractured twice and both styloid processes once. One fracture-dislocation was compound.

Complications—A transient median palsy occurred four times and avascular necrosis of the proximal scaphoid fragment was observed in three cases.

Treatment—Reduction was usually obtained by the same type of manipulation as for simple dislocation of the lunate; but it was more difficult and failed in two cases, one seen within a few hours of injury and the other after ten days. After reduction the wrist was immobilised in forty degrees of palmar flexion for three weeks, the plaster including the proximal joint of the thumb. Thereafter the wrist was maintained in the neutral or slightly dorsiflexed position, as a rule until the scaphoid was united.

In both cases where closed reduction failed the displaced lunate and scaphoid fragment were excised. In two others the scaphoid fragment, although reduced, was excised on account of avascularity.

Results—Two patients treated conservatively throughout obtained reasonably good results: in one, bony union of the scaphoid was secured after six months in spite of avascularity of the proximal fragment; but in the other union remained doubtful after four months. Of the two cases treated by excision of the avascular proximal scaphoid fragment, the result was fair in one but not recorded in the other. Excision of the unreduced lunate and portion of scaphoid gave one good and one fair result.

PERILUNAR DISLOCATION OF THE CARPUS—THREE CASES

In this injury the scaphoid remains intact and undergoes rotational subluxation as the carpal bones are displaced backwards on the lunate; thus the tubercle of the scaphoid comes to point into the palm and the proximal pole faces backwards. The treatment is the same as for the similar trans-scaphoid dislocation, except that the wrist need be immobilised for only three or four weeks.

Two early cases were reduced by manipulation, one with a good result, the other not yet assessed. The third patient was first seen three months after injury with the dislocation unreduced; despite antero-posterior broadening of the wrist and gross limitation of wrist movement, the grip was good and there was little pain in the wrist. One patient had a transient median palsy, but no vascular complications were seen.

SUBLUXATION, RECURRENT SUBLUXATION, AND DISLOCATION OF THE SCAPHOID—FIVE CASES

Subluxation of the scaphoid—one case. In this condition the scaphoid undergoes a rotational subluxation with dorsal displacement of the proximal pole. In one patient who was seen early the antero-posterior radiograph showed a gap between the scaphoid and lunate bones (Fig. 3A). The injury, however, was complicated by fractures of the radial styloid and triquetrum and by a previous atrophic arthritis of the wrist. The displacement was reduced with the wrist in dorsiflexion and radial deviation; this position was maintained for six weeks and the reduction remained stable (Fig. 3B).

Recurrent subluxation of the scaphoid—three cases. Three patients had sustained their injuries from three months to two years before examination and the subluxation had become recurrent. They complained of a click, usually painful, when the wrist was flexed in the palmar direction. There was also some impairment of wrist movement and of grip. The subluxation could be confirmed from the radiographs. The characteristic click on flexion of the wrist may be due to the radial extensor tendons slipping over the projecting proximal pole of the scaphoid, but more probably to the scaphoid slipping over the posterior margin of the radius. It can be eliminated by pressure over the postero-lateral aspect of the wrist.

When subluxation is recurrent and the symptoms warrant operative treatment, it is probably best to make the reduction secure by arthrodesis of the scaphoid to the lunate bone. In one case so treated the interosseous scapho-lunate ligament was absent and the dorsal radio-carpal ligament was very much attenuated. After removal of the adjacent articular cartilage, small bone chips from the lower end of the radius were packed between the two bones and the wrist was immobilised in plaster for four and a half months. Although sound fusion was doubtful, the patient had a useful range of wrist movement, a fairly powerful grip and no symptoms seven months after operation. In another patient with recurrent subluxation the scaphoid was excised; the result was not satisfactory. The third patient simply had manipulation of the wrist followed by active exercises; as his symptoms were relieved at the time this simple treatment may be worth a trial before scapho-lunate arthrodesis is considered.

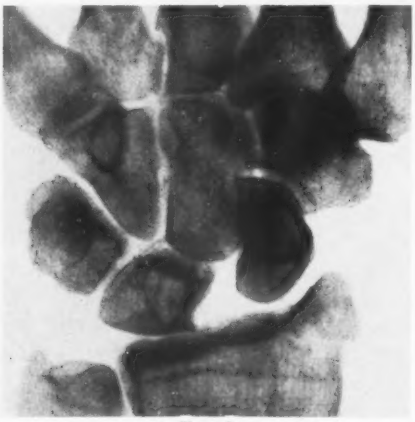

FIG. 3A
Subluxation of the scaphoid in an arthritic wrist; the radial styloid and triquetrum were fractured.

FIG. 3B
The same case after reduction, which remained stable.

Dislocation of the scaphoid—one case. This injury was sustained in a fall off a motor-cycle. The wrist was locked in ulnar deviation (Fig. 4) and a tender prominence was palpable near the tip of the radial styloid process. The radiographs showed the proximal pole of the scaphoid lying on the postero-lateral aspect of the radial styloid and the tuberosity tilted anteriorly; the capitate had slipped proximally towards the scaphoid space (Fig. 5).

Manipulative reduction was not difficult, traction being used on the hand and direct pressure on the displaced scaphoid. The wrist was immobilised in dorsiflexion and abduction for five weeks. Three months after injury, wrist movements were approximately three-quarters of normal; the patient had a powerful grip without pain, and there was no radiographic evidence of impairment of the blood supply to the scaphoid.

OTHER CARPAL DISLOCATIONS

Anterior dislocation of the trapezium—one case. This was a compound injury caused by a metal box falling on the hand. The trapezium was dislocated forwards on the scaphoid,

FIG. 4

A case of dislocation of the scaphoid, showing ulnar deviation of the hand.

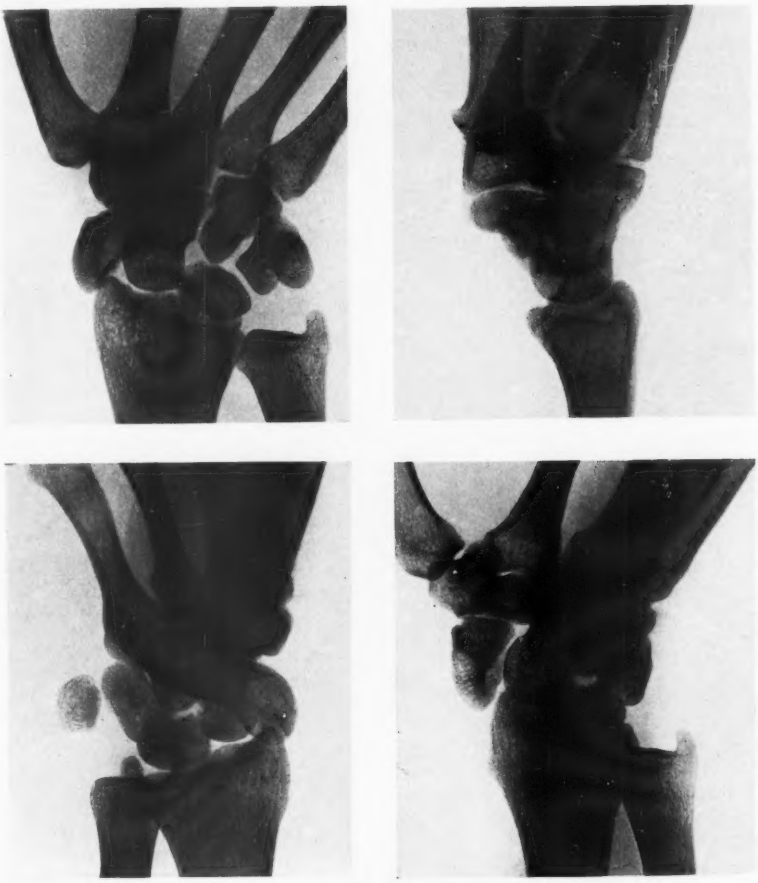

FIG. 5

Radiographs showing dislocation of the scaphoid. The proximal pole is lying on the postero-lateral aspect of the radial styloid and the tuberosity is tilted anteriorly.

carrying the first metacarpal with it; the base of the second metacarpal was fractured. Reduction was not obtained at the time of wound excision and the dislocation was accepted, plaster fixation being discarded after eighteen days. Ten weeks after injury, the patient had full wrist and finger movement and a fairly powerful grip. Apart from some loss of dexterity and slight pain when grasping with the thumb and index finger, the function of the hand was normal.

Posterior dislocation of trapezoid—one case. This patient was first seen two months after injury. The deformity was obvious; wrist movement was limited and painful when forced. Radiographs showed the trapezoid displaced backwards together with the second metacarpal. No special treatment was undertaken and the patient was invalided from the Service six months later.

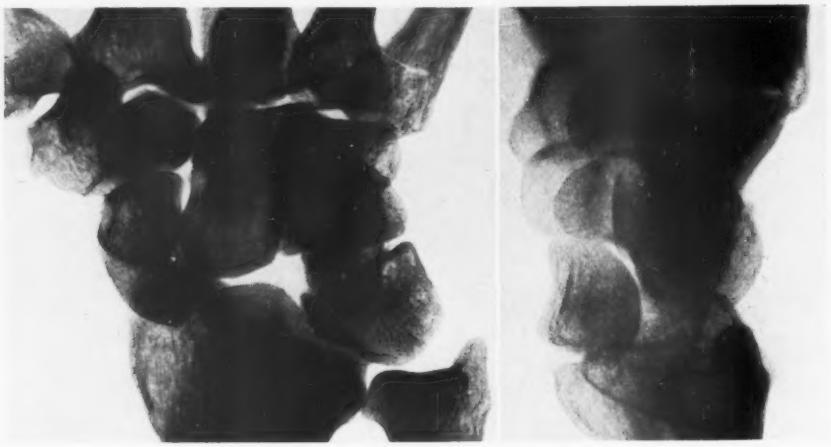

FIG. 6
Anterior dislocation of lunate and perilunar dislocation of carpus, with fracture of the tip of the radial styloid.

Anterior dislocation of lunate and perilunar trans-styloid fracture-dislocation—one case. The patient, a man aged fifty-six years, sustained this injury when his sleeve was caught in moving machinery. Radial displacement could be seen and the finger and wrist movements were markedly restricted. Radiographs showed an anterior dislocation of the lunate, a postero-lateral shift of the other carpal bones and a fracture of the radial styloid process (Fig. 6). The displacement was reduced and the wrist immobilised in palmar flexion and ulnar deviation. After ten days the degree of palmar flexion was reduced and the plaster was discarded after a further four weeks. The patient returned to his work as a brass-finisher three and a half months after injury. The radiograph now shows the common tendency for a lunate bone which has been dislocated to tilt backwards. A year after injury the patient is working and has only slight discomfort; movements are almost full.

Dislocation of capitate and trapezoid—one case. This patient, aged seventy-one years, was knocked down by an omnibus. A wound extended along the distal crease of the wrist and round the ulnar side to the dorsum. The radiograph showed postero-medial dislocation of the capitate together with the third and fourth metacarpals, and posterior dislocation of the trapezoid carrying the second metacarpal (Fig. 7). In addition, a triangular fragment of bone had been separated from the posterior margin of the base of the third metacarpal.

At operation the medial articular surface of the capitate was readily visible on the dorsum of the hand. The skin on the ulnar side of the hand could not be closed completely, but elsewhere it was sutured after reduction of the dislocation. Plaster was applied with

the wrist joint in palmar flexion and the unsutured area was covered by a split-skin graft twelve days later. The wounds healed cleanly and immobilisation was discontinued after a total of ten weeks. Six months after the injury the patient had no pain, a powerful grip and approximately one-third of the normal wrist movement.

SUMMARY AND CONCLUSIONS

1. Fifty-nine patients with various inter-carpal dislocations have been reviewed.
2. In this series trans-scapho-perilunar fracture-dislocation was the commonest injury. Early cases can be reduced by closed manipulation but in late cases operative reduction is usually advisable. When the injury is more than three months old, arthrodesis of the wrist joint is indicated.

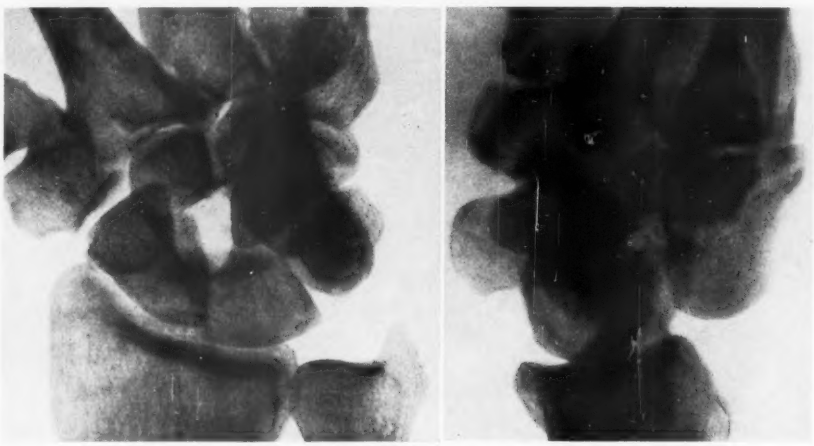

FIG. 7
Dislocation of capitate with the third and fourth metacarpals, and of the trapezoid with the second metacarpal.

3. When trans-scapho-perilunar fracture-dislocation was complicated by avascular necrosis of the proximal scaphoid fragment, the results in a small series treated by early excision were approximately equal to those treated by continued immobilisation. The results of grafting the scaphoid were poor.
4. Dislocations of the lunate seen within ten days of injury could usually be reduced with good results; no such case developed Kienböck's disease within the period of review. In late cases excision gave satisfactory results.
5. Forward dislocation of the lunate with half the scaphoid gave good results when manual reduction succeeded, but the results of excision of fragments were less satisfactory.
6. There was one case of forward dislocation of the lunate together with the *distal* half of the scaphoid.
7. Subluxation of the scaphoid is disclosed in antero-posterior radiographs by a typical gap between it and the lunate bone. The subluxation may become recurrent and present a characteristic syndrome.
8. Other rare dislocations of the carpal bones are described.

These patients have been treated under the supervision of Sir Reginald Watson-Jones, Mr H. Osmond-Clarke, Mr I. L. Dick and Mr Alexander Miller, and I wish to acknowledge my indebtedness to them.

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A CASE OF RECURRENT SUBLUXATION OF THE CARPAL SCAPHOID

O. J. VAUGHAN-JACKSON, LONDON, ENGLAND

From the Orthopaedic and Accident Service, the London Hospital

While fractures of the carpal scaphoid are common, isolated dislocations and subluxations of this bone are rare. The case of recurrent subluxation reported here seems to merit recording, particularly in view of the well-defined symptoms, signs and radiographic findings.

A man aged thirty-one years attended the London Hospital in June 1948, complaining that three months earlier he had "sprained" his right wrist while playing Rugby football. He was not sure of the exact nature of the injury and did not think much of it at the time. Later he noticed that forced palmar-flexion of the right wrist joint caused pain over the radial half of the dorsum of the joint and, in particular, that during rapid dorsiflexion, as in the act of throwing a dart, the wrist would click and he would momentarily lose the power of grip.

On examination the wrist showed no external abnormality and no loss of movement in any direction. The grip was strong; but dorsiflexion movement caused an audible snap in the joint, after which the proximal pole of the scaphoid could be seen to be unusually prominent on the dorsum of the joint. The snap was very much under voluntary control and could be produced or suppressed at will.

The first radiographs showed no abnormality (Fig. 1), but with the patient's co-operation it was possible to take films while the proximal pole of the scaphoid remained prominent on the dorsum (Fig. 2). These radiographs showed that the scaphoid was in fact subluxated so that the distal pole looked straight forward and the proximal pole straight backwards; the long axis of the bone was then at right angles to the long axis of the forearm. This can be seen clearly in the lateral view; in the antero-posterior view the scaphoid has a distorted foreshortened appearance, with a space between it and the radial side of the semilunar bone.

The patient had such perfect control over his disability that he was unwilling to have anything much done in the way of treatment, least of all any operative measure such as scapho-lunate arthrodesis; but he did agree to wear a moulded leather wrist-strap which was prescribed in the hope that if the subluxation were prevented for six to eight weeks the stretched capsule of the wrist joint might contract sufficiently to ensure stability. After three months, however, he could still produce the subluxation at will and declined to put up with the inconvenience of the strap any longer.

Comment—The picture of recurrent subluxation of the carpal scaphoid is a clear one. An obscure injury to the wrist joint is followed by snapping of the joint during dorsiflexion, with momentary loss of grip and the appearance of a dorsal prominence over the scaphoid. Radiographs taken during displacement show the scaphoid lying in the antero-posterior direction with the proximal pole on the dorsum, and a gap between the scaphoid and semilunar.

FIG. 1

Antero-posterior and lateral views of the wrist joint with the subluxation reduced, showing normal radiographic appearances.

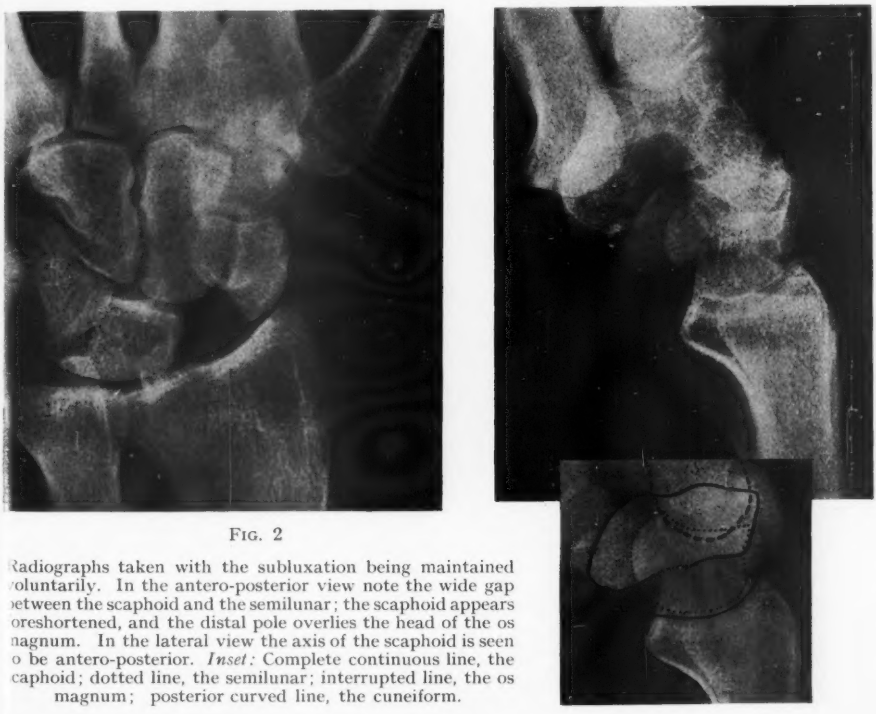

FIG. 2

Radiographs taken with the subluxation being maintained voluntarily. In the antero-posterior view note the wide gap between the scaphoid and the semilunar; the scaphoid appears foreshortened, and the distal pole overlies the head of the os magnum. In the lateral view the axis of the scaphoid is seen to be antero-posterior. *Inset:* Complete continuous line, the scaphoid; dotted line, the semilunar; interrupted line, the os magnum; posterior curved line, the cuneiform.

OSTEOARTHRITIS OF THE TRAPEZIO-METACARPAL JOINT

CH. LASSERRE, D. PAUZAT and R. DERENNES, BORDEAUX, FRANCE

The trapezio-metacarpal joint is the most important site for hypertrophic arthritis in the hand. The condition has been studied in France by Charcot and by Léri (1926), Robert (1936), Forestier (1937) and Huc and Badie (1941). We recently continued this work from both the radiological and clinical view, especially with regard to early diagnosis.

Anatomically, the trapezium is an intermediate bone placed in a particularly vulnerable position between the hammer of the first metacarpal and the anvil of the scaphoid. The normal arrangement of the bones is well known, but in about one case out of fifty the distal margin of the trapezium shows a marked exaggeration of the normal concavity (Fig. 3).

Physiologically, there are two main movements at the trapezio-metacarpal joint: antero-posterior flexion which is visible but difficult to analyse in radiographs, and lateral

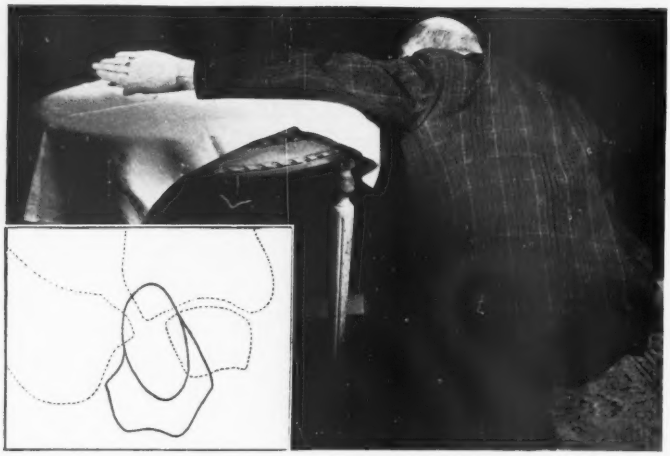

FIG. 2
To show the superimposed rounded outline obtained with incorrect positioning.

FIG. 1
The radiographic position which ensures clear outlines of the trapezium: the forearm and hand are fully pronated.

movement permitting abduction and adduction which is easy to study from radiographs made in forced pronation. These two movements are combined during opposition. Let us consider the lateral movement. During abduction the metacarpal fills exactly the transverse hollow of the trapezium (Fig. 4), but in adduction it slides laterally tending to leave the medial part (Fig. 5). The amount of sliding is usually very little, but in some cases the medial third of the hollow is uncovered. In rare instances the metacarpal is subluxated even during abduction, and this permanent physiological subluxation is a cause of error to be avoided (Fig. 6). The " step " sign of Forestier, *le signe de la marche d'escalier*, consists of a deformity of the base of the thumb caused by this radial subluxation of the first metacarpal.

Radiologically, the diagnosis of trapezio-metacarpal arthritis was difficult and uncertain until Robert (1936) demonstrated the value of placing the hand in forced pronation. The standard dorso-palmar film is of no practical use at all, except in advanced cases when it merely confirms the presence of a grave lesion of the joint. We must draw attention to possible errors in the interpretation of dorso-palmar views. At the level of the trapezium an

FIG. 3
Exaggeration of the normal concavity of the trapezium and prolongation of the medial and distal angle.

FIG. 4
In abduction of the thumb the base of the first metacarpal exactly fills the transverse hollow of the trapezium.

FIG. 5
In adduction of the thumb the base of the metacarpal glides laterally.

FIG. 6
Showing marked physiological subluxation of the metacarpal.

FIG. 7
Showing narrowing of the joint space, sclerosis of subchondral bone and osteophyte formation.

FIG. 8
Osteophyte formation on the medial and distal angle of the trapezium, and lateral subluxation of the metacarpal.

FIG. 9
To show osteophytes of unusual size at both the lateral and medial margins of the joint.

FIG. 10
La forme subluxante maxima: the base of the metacarpal is level with the trapezio-scaphoid joint.

oval image can often be seen with the long axis directed inwards and distally like the stone of a ring set obliquely (Fig. 2). The image ends in a rounded outline over the proximal ends of the first and second metacarpals. It is caused by the projection of the medial and distal part of the trapezium on to the rest of the bone. If an abnormality of the trapezio-metacarpal joint is suspected, a radiograph should be taken in a position of forced pronation, together with a view in profile. The position of the patient is important. To have the whole trapezium and all its borders properly displayed, the patient should kneel beside the table with the head bent forwards, the arm horizontal and the shoulder level with the hand (Fig. 1).

There are two groups of cases:

1) **Early trapezio-metacarpal arthritis**—Very often symptoms first arise during manual work. Radiographic changes in the joint may include: *a*) Narrowing of joint space. A reduction of 1·0 to 1·5 millimetres is common, but what is the margin of error? Stereoscopic examination always shows that the joint space is better outlined and much wider than it appears in routine radiographs. *b*) Subchondral condensation of bone. *c*) Lateral subluxation. *d*) Osteophyte formation on the lateral borders of the metacarpal and trapezium. Though this is given as an early sign by many writers, we have not been able to find it with any certainty in early cases. *e*) Deformation of the medial and distal angle of the trapezium. This is common and consists of an alteration in the distal curve of the trapezium beginning near the junction of the inner third and the outer two-thirds, prolongation of the distal and medial angle into the space between the proximal extremities of the first two metacarpals, and early osteophyte formation in the same region (Figs. 7 and 8). We think that the medial part of the articular surface is the starting point of the arthritic process and that this corresponds to the area where pressure transmitted through the adducted thumb is most frequently and powerfully felt.

FIG. 11
A suitable appliance.

2) **Gross trapezio-metacarpal arthritis**—The diagnosis can be made clinically and the radiographs show clear details of the lesion (Fig. 9). In an extreme case dislocation can be so marked that the base of the metacarpal is opposite the trapezio-scaphoid joint. This is the type with maximum subluxation, *la forme subluxante maxima* (Fig. 10). The joint space is not visible, but screening during movement shows that it is partly preserved. In all cases the greatest deformity and largest osteophytes are at the distal and medial angle of the trapezium. This is a point of first importance.

Treatment—At the least suspicion of trouble the patient should wear an apparatus to hold the trapezio-metacarpal joint at rest in abduction (Fig. 11). We demonstrated a suitable appliance made of a very light plastic material (Paladon) at the International Scientific Conference held at Aix-les-Bains in June 1948.

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EXCISION OF THE TRAPEZIUM FOR OSTEOARTHRITIS OF THE TRAPEZIO-METACARPAL JOINT

W. Harvey Gervis, Tunbridge Wells, England *

Osteoarthritis of the trapezio-metacarpal joint may be monarticular and probably is often traumatic in origin. Table I is an analysis of fifteen patients with disability severe enough to justify operation. The series is small because the condition is not very common. It is found in later life and mainly in women. The right side is more often affected than the left but both joints are sometimes involved. The figure for bilateral cases rather underestimates the frequency; a few other patients had slight symptoms on the opposite side not severe enough to require operation. Although there was a history of injury in only a third of the patients, there may have been unremembered injuries in others, and it is probable that injury is one of the main factors in causation. More than half of the patients were under the age of sixty and therefore required painless use of the thumbs for active work.

TABLE I

Number of patients	15
Number of trapezia excised	18
Sex—Male	5
Female	10
Age—Under 40 years	0
40–50 years	4
50–60 ,,	4
60–70 ,,	5
70–80 ,,	2
Side—Right	7
Left	5
Bilateral	3
General arthritic changes	2
History of injury	5

With regard to treatment, palliative measures cannot restore the articular surfaces, while arthrodesis of the joint is not easy, requires prolonged after-treatment and limits movement of the thumb. Removal of the trapezium is a simple form of arthroplasty and the results of this operation will be discussed.

Clinical features—All the patients complained of pain about the base of the thumb, especially on movement. There was usually some obvious swelling and in four cases a diagnosis of ganglion had been made. Movement of the joint caused pain and crepitus could often be felt.

Radiographic appearances—Loss of joint space was associated with one or more of the following changes: simple osteophyte formation (Fig. 1); radial subluxation of the metacarpal bone (Fig. 2); or small ossicles about the joint (Fig. 3).

TECHNIQUE OF OPERATION

With a tourniquet applied, an incision is made parallel to extensor brevis pollicis in the distal part of the anatomical snuff box. The joint between the trapezium and first metacarpal is easily identified and opened widely; it may be found distended with fluid. Damage to the last part of the radial artery where it crosses the trapezium on its way to the deep palmar arch must be avoided. The ligaments are dissected off the bone in a proximal direction till the articulation with the scaphoid is reached. A raspatory is then inserted into this joint to retract and protect the artery while the articulations with the trapezoid and second metacarpal bones are defined. In working round the palmar surface and dissecting off the transverse carpal ligament it is important to keep close to the bone, or the tendon of flexor carpi radialis may be damaged in its groove in the trapezium. With careful dissection, using a small bladed knife the tendon should not be seen during the operation. Even when all the attachments of the bone have apparently been separated, it may be disinclined to

* *Paper read at the Annual Meeting of the British Orthopaedic Association*, 1948.

come out. The temptation to lever the bone out forcibly must be resisted lest some fragments be left behind. Examination of the trapezium after removal shows loss of the articular cartilage with eburnation of the bone; in some cases the articular surface is grooved from long-standing subluxation.

Post-operative treatment—A firm pressure bandage is applied before removal of the tourniquet, but care is taken to avoid restriction of movements of the thumb. Active movements are started at once. Because of pain, many of these patients have long avoided movement of the first carpo-metacarpal joint and supervision is necessary to see that the thumb is moved through a full range.

FIG. 1

FIG. 2

FIG. 3

Characteristic radiographic appearances of osteoarthritis of the trapezio-metacarpal joint. Loss of joint space is associated with osteophyte formation (Fig. 1), subluxation (Fig. 2), or formation of discrete ossicles (Fig. 3).

RESULTS

There are two patients in the series in whom the results are inferior and both show general arthritic changes. The first is the only patient who is not glad to have had the operation. She was aged seventy-one years and had generalised osteoarthritic changes, especially of the knees, to some extent of the hands, and slightly in the right trapezio-metacarpal joint. The left trapezium was excised a year ago on account of considerable pain on that side. Now there is full and painless movement of the first metacarpal bone and in this respect function is greatly improved. But the arthritic changes in the fingers have increased with wasting of the intrinsic muscles, so that the function of the hand as a whole has deteriorated.

The second patient was aged fifty-four years and had pain from severe osteoarthritis in both trapezio-metacarpal joints with marked subluxation. There were mild arthritic changes in the wrists and fingers, more of the rheumatoid type. Both right and left trapezia were removed and, though movements of the first metacarpal bones are now free and painless

there are slight effusions into the wrist joints and the patient complains that the thumbs are still weak.

The results in the remaining cases have been uniformly good. Two patients were operated upon early in 1944. One was a seamstress aged forty-six years, with increasing pain in the right thumb and difficulty in her work over a period of four years. She returned to full work after three weeks and the joint remains free from pain. Radiographs show a fragment of bone that has formed a small trapezium, but this does not seem to impair the function of the arthroplasty. The other patient was aged fifty-eight years; the left thumb was affected and the radiographs showed small discrete ossicles (Fig. 3). She has written to say that some time elapsed before she recovered efficient use of the thumb, which is now quite satisfactory.

The next patient, seen in 1945, was a farm worker aged forty-eight years, who had suffered for some years from pain in his right thumb which he dated from an injury. He resumed farm work two months after operation, but returned in 1947 complaining of the left thumb, which showed severe osteoarthritis. The trapezium on this side was removed; he has been doing full farm work ever since and is free from pain. Figure 4 shows the condition of the right thumb four years after operation. Another patient seen in 1945 was a woman aged fifty-three years with bilateral changes. Both trapezia were excised. She is very satisfied, but states that there is some weakness in the thumbs for such a movement as turning a tap.

The next patient was seen in 1946, a man complaining of pain and diminished movement of his right thumb. At that time he was a night watchman, but now does full work in the kitchen of a restaurant. Another patient operated upon in that year was a cowman aged forty-nine years who was unable to work because of severe pain in his right thumb (Fig. 2). One month after operation he was milking twenty cows a day.

FIG. 4

The right wrist of a man aged forty-eight years taken four years after operation. The left trapezium was subsequently removed and he has returned to full farm work.

In more recent cases the results have continued to be satisfactory though older patients tend to be slow in gaining full recovery.

SUMMARY

1. The technique of excision of the trapezium for osteoarthritis of the trapezio-metacarpal joint is described.

2. The results of eighteen operations in fifteen patients are analysed.

3. The operation is of value particularly when the arthritis is monarticular. Results have been less satisfactory when the affection of the joint is part of a generalised arthritis.

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ARTHRODESIS OF THE TRAPEZIO-METACARPAL JOINT FOR OSTEOARTHRITIS

G. M. MÜLLER, LONDON, ENGLAND

From the Orthopaedic Unit, St Peter's Hospital, Chertsey

Painful osteoarthritis of the trapezio-metacarpal joint may result from occupations involving repetitive use of the thumb. Mild symptoms are common in middle-aged women, but advanced changes may be found in factory workers and particularly in those doing heavy sewing such as upholstery or mattress-making. In severe cases the thumb is held adducted and is used with caution; grasping, pinching and wringing movements are uncomfortable, and the lifting of heavy objects requiring a wide grip causes much pain.

Examination shows some swelling and local tenderness from synovial and capsular thickening. Abduction and extension movements are limited and opposition is carried out with difficulty. Thus for a pincer grip the pulp of the thumb is applied to the distal joint of the index, whereas normally both tips meet to form an "O" in a position of great strength of the thumb. In addition to sclerosis of the subchondral bone and osteophytic lipping, radiographs often show a small detached osteophyte on the lateral aspect of the joint at the site of maximum tenderness.

FIG. 1

To illustrate the technique of arthrodesis of the trapezio-metacarpal joint.

FIG. 2

To show sound arthrodesis with a bone graft from the ilium (Case 3).

Arthrodesis of the joint and excision of the trapezium (Gervis 1948) are two methods of dealing with the more severe cases. A sound arthrodesis retains the stability and power of the thumb, and the continuity of the line of bones from the radius through the scaphoid and trapezium to the first metacarpal being intact, the system is not deprived of one of its units of leverage. A case of "failed arthrodesis" can be treated by a second graft if symptoms continue, whereas grafting after "failed excision" of the trapezium must be difficult. One disadvantage is some difficulty in obtaining sound fusion because the subchondral bone of the trapezium is sclerotic and there is little enough of the bone left after complete excision of the articular surface. Post-operative fixation must therefore be efficient and prolonged. Another disadvantage is the need for a separate incision over the tibia or ilium to obtain a bone graft of good quality. There is no doubt that a graft is essential for the reason that simple excision of the joint gives rise to fibrous ankylosis.

Technique of arthrodesis—The bones are exposed from the lateral subcutaneous aspect and the insertion of extensor ossis metacarpi pollicis is elevated. A narrow slot is cut in the first metacarpal and trapezium; in this way the alignment of the bones is not altered subsequently. The accessible capsule, the synovial membrane of the trapezio-metacarpal

joint, and then the joint surfaces are excised; particular attention is paid to the medial part of the saddle-shaped surface of the trapezium which is difficult of access. The bones having been fitted together accurately, the graft is skidded into the slot and tightly impacted (Fig. 1).

Source of the graft—In one case the oblong of metacarpal shaft raised from the slot was used as a sliding graft, but the quality of the bone was poor. Tibial grafts were used in four cases; one bilateral case operated upon by a colleague for the second side ended with a pseudarthrosis. The last three cases have had iliac grafts including some cortical bone cut with a finger chisel in one piece from the crest. A few cancellous chips have supplemented the main graft. The greater osteoblastic activity and elasticity of iliac bone make it superior to tibial bone for this purpose.

After-care—The thumb and wrist are fixed in a scaphoid type of plaster with the thumb in mid-opposition, and the limb is elevated for a few days. After two or three weeks a well-fitting cast is applied over stockinette and immobilisation is continued for a total of at least four months. When iliac bone is used even longer may be required despite the radiographic appearances. In two recent cases the plaster was removed after four months, when there was no tenderness locally or pain on springing the bones and when the radiographs seemed satisfactory, but within a week pain and tenderness recurred and fixation had to be resumed.

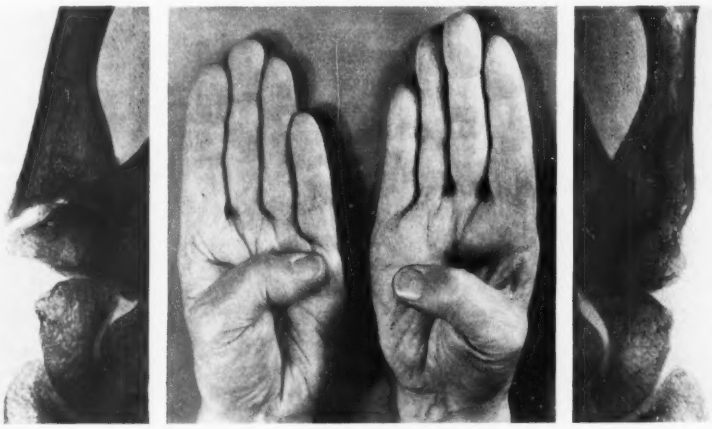

FIG. 3

Case 4. To show the range of opposition after operations resulting in fibrous ankylosis of the left trapezio-metacarpal joint and sound fusion of the right joint.

Results—Eight operations have been carried out on seven patients. Six joints fused soundly and gave excellent and painless function. One patient remains untraced. In one bilateral case for which tibial grafts were used, the right side gave a sound arthrodesis but the left side, operated on two years later, ended with fibrous ankylosis (Fig 3). At review four years after the second operation this patient said there was no difference in function between the two sides; she was working again as a draper's assistant, gripping heavy rolls of cloth between each thumb and forefinger with no loss of power.

CASE REPORTS

Case 1. Mrs F. S., aged fifty-eight years, housekeeper—Pain and swelling in right thumb for five months, increasing in severity. Arthrodesis with sliding metacarpal graft, March 1943. Plaster removed after four months; fusion solid. Good function subsequently.

Case 2. R. S., aged thirty-two years, tank mechanic—Blow on base of left thumb three year previously. Radiographs showed unusual prominence of the base of the first metacarpal and a distorte trapezium, with osteoarthritis in the carpo-metacarpal joint. Arthrodesis with tibial graft, August 1945 Plaster removed after five months; good function regained within a fortnight.

Case 3. Mrs H. S., aged fifty-eight years, factory worker—Pain in the joint since changing one typ of work for another, both types involving repetitive thumb movements. Arthrodesis with iliac graft June 1948 (Fig. 2). Plaster removed after five months; early return of full function. Now able to touc the basal crease of the little finger with the tip of the thumb; free from pain and very pleased with th result.

Case 4. Mrs E. M., aged fifty-three years, draper's assistant—Long-standing pain in both thumbs, worse on the right side. Right side grafted in October 1943 with tibial bone. Plaster for five month and sound arthrodesis. Left side operated on in January 1945, again with a tibial graft. Pseudarthrosi occurred on this side. When seen in June 1948, the patient was pleased with both results and there wa no difference in function or movement. She was able to oppose each thumb to the proximal phalanx of the little finger (Fig. 3).

Case 5. Mrs B. L., aged forty-two years, upholsterer—Severe symptoms in left thumb for two years. Arthrodesis with iliac graft in May 1948. Plaster for five months; full painless movement soon after. Able to oppose tip of thumb to basal crease of little finger.

Case 6. Mrs A. C., aged fifty-one years, housewife—Arthrodesis with a tibial graft in December 1944. Patient cannot be traced.

Case 7. Mrs P. C., aged fifty-seven years, housewife—Symptoms in left thumb for two years. Arthrodesis in July 1947 with iliac bone. One year later, painless and excellent function.

Comment—Apart from the relief of pain given by the fusion the most striking feature of these cases is the early return of function after removal of the plaster cast. Arthrodesis of the trapezio-metacarpal joint scarcely affects the range of movement of the thumb, probably because of the compensatory increase in the range of the trapezio-carpal joints.

I am indebted to Mr B. H. Burns for permission to report five cases and for his stimulating interest; to Mr V. H. Ellis for a further case; and to Mr R. T. Whitley of the Institute of Orthopaedics for the printing of the radiographs.

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A CONGENITAL ABNORMALITY OF THE TRAPEZIUM AND FIRST METACARPAL BONE

A. F. RUSHFORTH, LONDON, ENGLAND

From the Institute of Orthopaedics, Royal National Orthopaedic Hospital

Congenital abnormalities of the trapezium are uncommon. In this patient the trapezium and the base of the first metacarpal were affected on both sides.

Case history—Mrs L. E., aged sixty-five, attended for a painful exostosis of the foot, but it was noticed that both hands were abnormal. She stated that the base of each thumb had been deformed since childhood; there was no history of injury and no relevant family history. The condition caused little inconvenience, though she had noticed that the range of movement was less than normal and had diminished with advancing years. She was able to carry out her household duties without pain.

FIG. 1

The dorsal aspect of the patient's hands. Note the prominence of the base of each first metacarpal.

Examination—On each side there was marked prominence of the base of the first metacarpal (Fig. 1). There was no wasting of the thenar muscles and no local tenderness. The range of movement at the carpo-metacarpal joint was limited, particularly abduction and extension. Opposition, however, was almost normal. The metacarpo-phalangeal joint was unusually mobile. Apart from hallux valgus, no other abnormality was discovered.

The radiographs showed that the abnormality was almost symmetrical, and consisted of enlargement of the base of the metacarpal and gross alteration in shape of the trapezium, which was longer than normal and presented an acute angle on the radial aspect (Figs. 2, 3). Each trapezio-metacarpal joint was deformed. There was a separate ossicle in each hand, on the right at the outer angle of the trapezium forming part of the joint surface, and on the left on the palmar surface, seen more clearly in the lateral radiograph in the position of the tuberosity. The trapezio-metacarpal joints were obviously arthritic with narrowed joint spaces, but were also distorted as if they had migrated proximally.

Review of the literature—Pfitzner (1895) produced a plan of the hand showing the numerous cartilaginous centres which could occur in the embryo and which might persist as

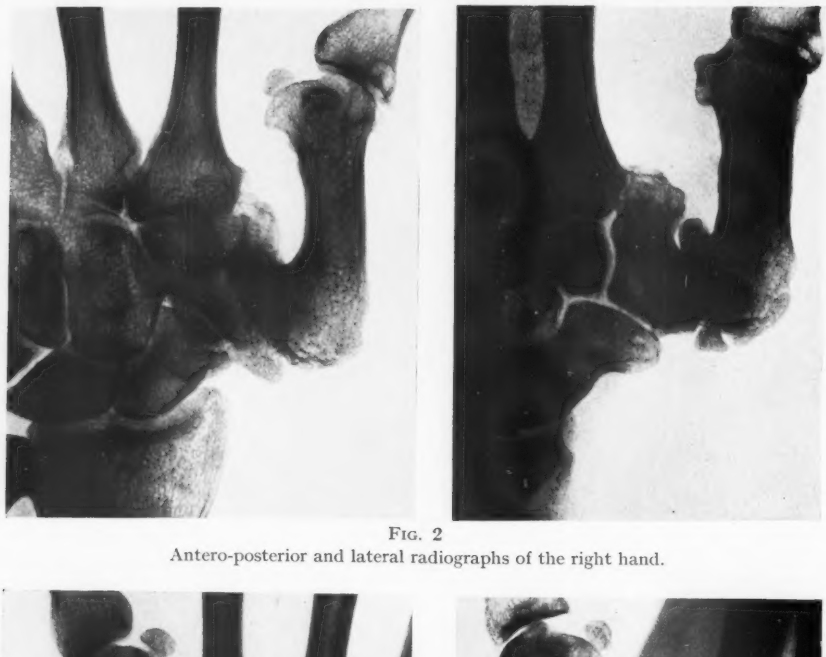

FIG. 2
Antero-posterior and lateral radiographs of the right hand.

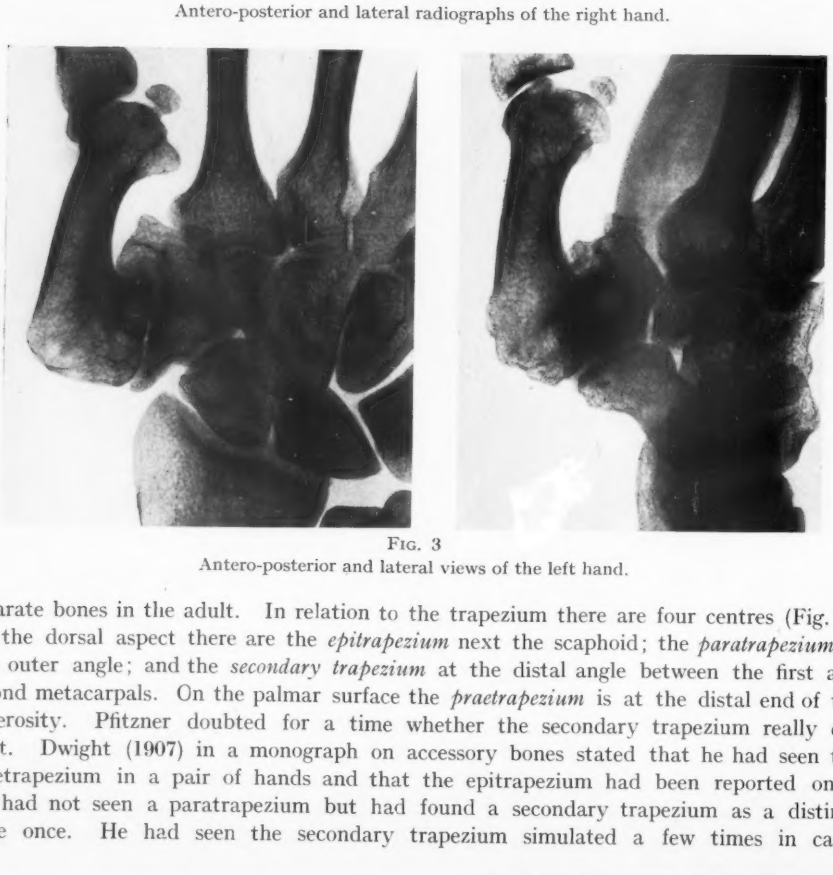

FIG. 3
Antero-posterior and lateral views of the left hand.

separate bones in the adult. In relation to the trapezium there are four centres (Fig. 4). On the dorsal aspect there are the *epitrapezium* next the scaphoid; the *paratrapezium* at the outer angle; and the *secondary trapezium* at the distal angle between the first and second metacarpals. On the palmar surface the *praetrapezium* is at the distal end of the tuberosity. Pfitzner doubted for a time whether the secondary trapezium really did exist. Dwight (1907) in a monograph on accessory bones stated that he had seen the praetrapezium in a pair of hands and that the epitrapezium had been reported once. He had not seen a paratrapezium but had found a secondary trapezium as a distinct bone once. He had seen the secondary trapezium simulated a few times in cases

with deformity of the first metacarpal and flattening of the trapezio-metacarpal joint, but he considered these cases pathological and did not reproduce the radiographs.

In a critical review of Pfitzner's plan Grumbach (1921) ascribed most of these accessory bones to injury, with the possible exception of the epitrapezium. Köhler (1928) and Bogart (1932) had seen no accessory trapezium elements. Brailsford in 1936 showed radiographs of a foundry worker similar to those of the present patient. In a private communication (1949) he stressed his conception of the etiology as that of repeated injury with resulting osteoarthritis.

Gruber (1875) found a patient with a praetrapezium in each hand. Cuyer (1887) described an ossicle in the position of the paratrapezium articulating with the first metacarpal (Fig. 5). He did not note any alteration in the metacarpal but his drawing suggests that the joint surface was longer than normal. Heimerzheim (1925) mentions a case similar to Cuyer's. In a study of inherited brachydactyly in a New Zealand family, Nissen (1933) found ten adults and one child with accessory carpal bones which included a praetrapezium in two instances.

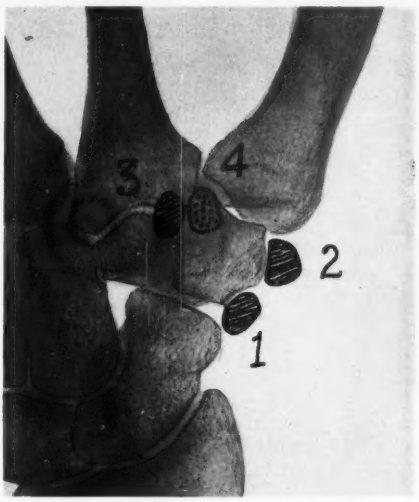

FIG. 4

A diagram of the accessory centres of the trapezium, from the dorsal aspect: (1) the epitrapezium, (2) the paratrapezium, and (3) the secondary trapezium. The praetrapezium (4) is on the palmar aspect.

Osteoarthritis of the trapezio-metacarpal joint with loose body formation is well recognised (Gervis 1948). This condition, however, gives rise to pain and disability whereas accessory bones seldom cause symptoms. Bennett's fracture-dislocation of the thumb may lead to secondary osteoarthritis, but the history is usually clear. Fusion of the trapezium with other carpal bones is very unusual. The only cases described are of fusion of the trapezium and scaphoid (Turner 1883 and Gougerot 1905).

Discussion—No doubt some of the previous writers would have ascribed the changes in this case to injury. The deformity, however, was noticed at an early age, and as it is bilateral and nearly symmetrical, must be regarded as congenital.

According to Pfitzner's plan, the trapezium at one stage may consist of a main centre and four minor cartilaginous centres which may persist and alter the shape of the bone. The secondary trapezium centre would enlarge the distal part of the bone between the first and second metacarpals and would tend to displace the trapezio-metacarpal joint surface proximally, while a persistent paratrapezium centre would enlarge the outer angle of the bone. The shape of the trapezium in this patient could thus be produced. It is significant that on the right side there is a paratrapezium similar to those described by Cuyer and by

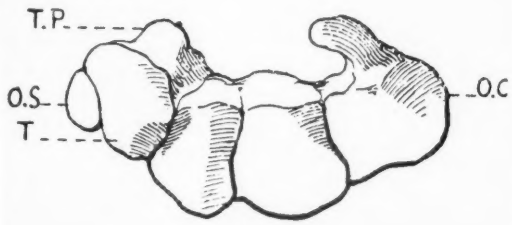

FIG. 5

The paratrapezium after Cuyer. The drawing shows the distal aspect of the carpus. T=trapezium, O.S=paratrapezium, O.C=unciform bone.

Heimerzheim, and that on the left side the ossicle is in the position of a praetrapezium. The abnormality of the metacarpal could well arise as a feature secondary to the deformation of the trapezium in its cartilaginous state. This explanation accords with the review of the literature.

SUMMARY

A bilateral congenital abnormality of the trapezium and first metacarpal is described. The condition may be related to abnormal ossification of the trapezium in accordance with Pfitzner's plan. It is quite distinct from osteoarthritis of the trapezio-metacarpal joints.

My thanks are due to Mr A. T. Fripp for permission to publish this case and to Mr R. J. Whitley for assistance with the illustrations.

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VARIATION IN EXTENSION OF THE METACARPO-PHALANGEAL AND INTERPHALANGEAL JOINTS OF THE THUMB

H. HARRIS and J. JOSEPH, LONDON, ENGLAND

From the Galton Laboratory and the Department of Anatomy, University College

Variation in the range of movement of different joints has often been studied by special instruments, so fitted to the limbs that they give direct readings. Radiographic methods have also been used but are often unsuitable when there is movement in more than one plane. For a hinge joint, true lateral radiographs can be used to give the angle between the two bones, provided that a suitable long axis can be chosen for each bone.

The range of extension movement of the thumb joints in the two authors of this contribution was found to be strikingly different (Figs. 2 and 3) and it was thought that a study of such variations in a random sample of the European population might be of interest. Some so-called " double-jointed " individuals can hyperextend the metacarpo-phalangeal joint of the thumb, and the incidence, variation and mechanism of such hyperextension were investigated. Extension of the joints of the thumbs was also measured in a number of Indians and West Africans in order to determine any racial differences.

MATERIAL AND METHOD

The students and staff of the Department of Anatomy were the main sources of our European samples; 133 male and 100 female Europeans, 31 male Indians and 30 male West Africans formed the several groups. In each subject a lateral view of the thumbs was taken with the metacarpo-phalangeal and interphalangeal joints extended fully. The carpo-metacarpal joint was extended fully, with the thumb midway between abduction and adduction and the thumb-nail at right angles to the film.

Standard longitudinal axes for the three bones had to be found on the radiographs. In the lateral view of the thumb the posterior surfaces of the metacarpal and proximal phalanx usually present straight lines which can be used as axes (Fig. 2). Sometimes the proximal phalanx does not show a well-defined straight line posteriorly, but in such cases a line may be drawn parallel to the greatest thickness of the cortical bone.

FIG. 1

The method used for measuring the interphalangeal and metacarpo-phalangeal angles.

The axis for the curved distal phalanx was more difficult to determine since the phalanx is always curved in a posterior direction. However, there is nearly always a straight line of cortical bone about one millimetre wide on the posterior aspect, and a line drawn on the posterior surface of the phalanx parallel to this was chosen as the axis. It might be argued that the greater the curvature of the distal phalanx the greater should be the angle between it and the middle phalanx. It was found, however, that the curvature did not vary enough to affect the results materially.

Once the axes were drawn, the angles between them were measured to the nearest half degree. When the two axes were parallel or in line, the angle of course was zero. A positive angle represented the number of degrees of extension beyond this position; if the axes did not reach this position, the angle was expressed as a negative figure (Fig. 1).

TABLE I

ANGLES AT INTERPHALANGEAL AND METACARPO-PHALANGEAL THUMB JOINTS RECORDED BY TWO OBSERVERS MEASURING EACH ANGLE THREE TIMES

Joint	Subject	Observer I			Observer II		
		a	*b*	*c*	*a*	*b*	*c*
Right I.-P.	1	36	36·5	36·5	40	38	41
	6	23	23	22	22	22	21·5
	7	1	0	1	2	9	2
	8	29	30	27	28·5	30	29
	9	70	71·5	70	68·5	73	73
Right M.-P.	1	26·5	24·5	26	26	25·5	25
	6	24	23·5	23·5	24	23	23
	7	3	4	3	2	3	3
	8	0	1	0	0	0	5
	9	−8	−8	−8	−7·5	−8	−6·5
Left I.-P.	1	62	61·5	62	61	62	62·5
	6	10	13	14	11	10	11
	7	7	7	7·5	13·5	10	10
	8	36	36	36	34	35	35
	9	46	50	47	49	50·5	50
Left M.-P.	1	24	24·5	25	26	25	25
	6	8	8	9	8	7	8
	7	6	8	5	8	7	6
	8	14	14	14	14·5	14	14
	9	45	46	45	46	46	46

TABLE II

ANGLES AT INTERPHALANGEAL AND METACARPO-PHALANGEAL THUMB JOINTS OF TEN SUBJECTS, EACH RADIOGRAPHED AGAIN AFTER AN INTERVAL

Subject	Right I.-P.		Right M.-P.		Left I.-P.		Left M.-P.	
1	60	63	26	27	61	62·5	25	28
2	16	17	9	4·5	21	15·5	11	9
8	28·5	33·5	0	1	35	32	14	6
11	25	26	16	17	35	35	21	18
13	42	42·5	0	0	33·5	31	1·5	4
15	30·5	28	11·5	11·5	41	41	−1·5	0
16	29	29	3·5	3·5	34	33	15	11
18	48	53	16·5	19·5	58·5	68·5	5	7·5
19	29	30	3	5·5	27	31·5	20	22
20	10	11	5	3	6·5	4	5	2·5

TABLE III

MEAN AND STANDARD DEVIATIONS OF THE ANGLES AT THE INTERPHALANGEAL THUMB JOINTS OF THE EUROPEAN GROUP

Sex	Side	Mean	Standard deviation	Number of observations
Male	Right	29·16	11·65	133
	Left	32·20	11·09	133
Female	Right	23·55	9·73	100
	Left	24·85	11·40	100

In view of the possibility of variation in the observers' interpretation and readings, two observers made three separate readings on radiographs of five subjects (*a*, *b* and *c* of Table I). In order to determine the variation in radiographic technique, ten subjects were radiographed twice with an interval between each film. The results are shown in Tables I and II. It was found that these possible errors were of the order of $\pm 2{\cdot}5°$ and quite small as compared with the differences in the angles found in various subjects.

Many of the subjects could produce further extension of the metacarpo-phalangeal joint when the carpo-metacarpal joint was flexed; in such cases a film was taken of the thumb in what will be referred to as the " second position " (Figs. 4–7).

FIG. 2

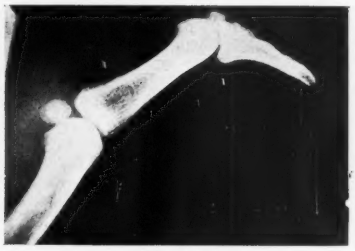

FIG. 3

To show the range of extension movement of the thumb joints in the two authors.

FIG. 4

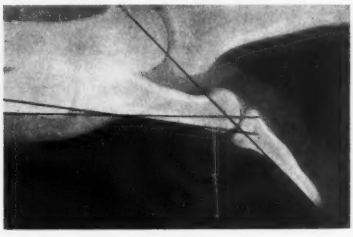

FIG. 5

Figures 4 and 5 show the common finding, that no further extension of the metacarpo-phalangeal joint occurs when the carpo-metacarpal joint is flexed.

FIG. 6

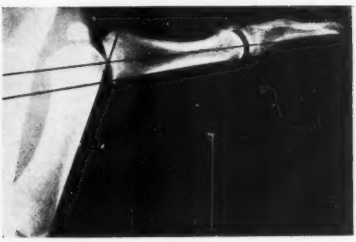

FIG. 7

Figures 6 and 7 show that in some subjects further extension of the metacarpo-phalangeal joint occurs when the carpo-metacarpal joint is flexed.

RESULTS

1) Interphalangeal joints—Figure 8 shows histograms of the angles at maximum extension of the interphalangeal joints of the right and left thumbs in European males and females. Certain conclusions can be drawn:

a) There is considerable individual variation; the greatest angle observed was $67{\cdot}5°$ and the smallest $0°$.

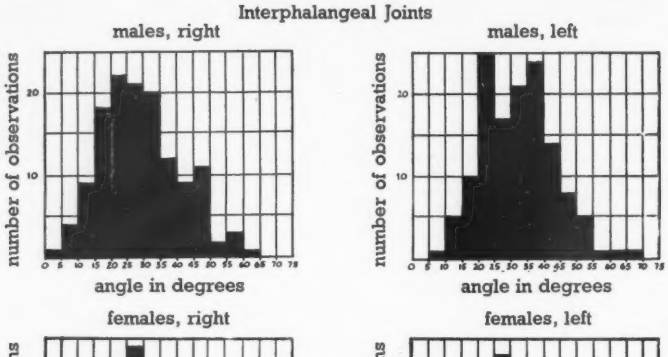

FIG. 8

Histograms of angles of maximum extension at the interphalangeal joints of the right and left thumbs in males and females.

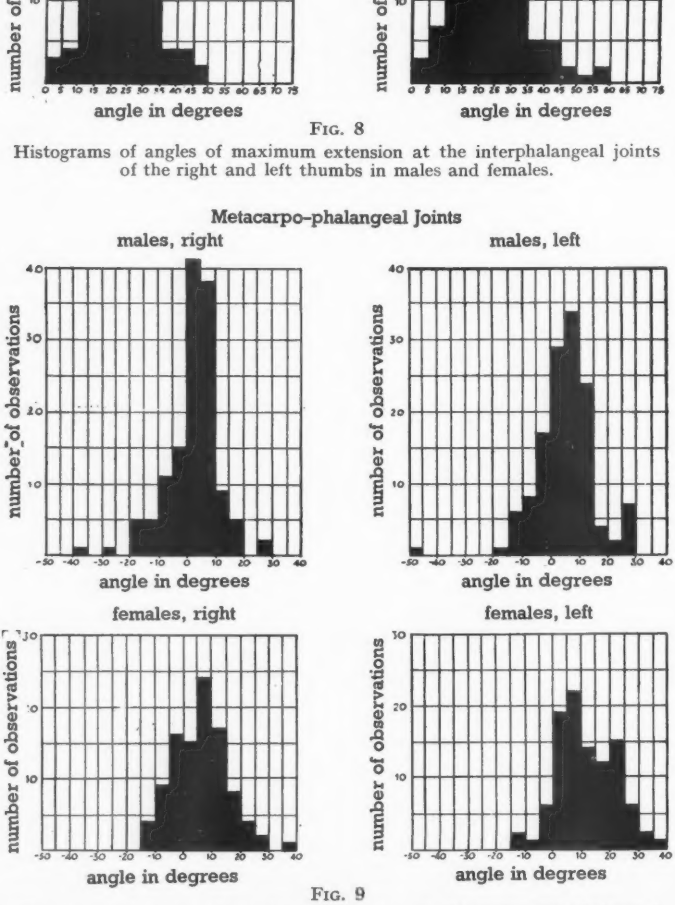

FIG. 9

Histograms of angles of maximum extension at the metacarpo-phalangeal joints (first position) of the right and left thumbs in males and females.

b) The distribution is fairly symmetrical; the means and standard deviations of the angles for the right and left sides in both sexes are given in Table III.

c) In the males the mean of the right is 3·04° greater than the mean of the left; this difference is barely significant. In the females the difference between the right and left is certainly not significant.

d) In both right and left thumbs the means in the males are significantly greater than those in the females.

e) There is a high correlation between the right and left joints in both males and females (r=0·66 in the males and 0·81 in the females).

2) Metacarpo-phalangeal joint—Figure 9 shows histograms of the angles of maximum extension at the metacarpo-phalangeal joints of the right and left thumbs in European males and females. The following conclusions can be drawn:

a) There is considerable individual variation in maximum extension at this joint; the greatest angle observed was 34° and the smallest −48°.

b) The distribution is fairly symmetrical; the means and standard deviations for the right and left sides in both sexes are given in Table IV.

c) In the males the mean of the right is 3·30° greater than the mean of the left, and in the females it is 5·60° greater; these small differences are statistically significant.

d) The mean of all the angles is small and the angle is often negative.

e) In both right and left thumbs the mean for the females is significantly greater than the mean for the males.

f) There is a high correlation in both sexes between right and left thumbs (r=0·59 in the males and 0·64 in the females).

TABLE IV

MEANS AND STANDARD DEVIATIONS OF THE ANGLES AT THE METACARPO-PHALANGEAL JOINTS OF THE EUROPEAN GROUP

Sex	Side	Mean	Standard deviation	Number of observations
Male	Right	2·31	9·22	133
	Left	5·62	9·71	133
Female	Right	5·95	9·59	100
	Left	11·55	9·97	100

3) The interphalangeal compared with the metacarpo-phalangeal joints—The maximum extension at the interphalangeal joint may be related to the maximum extension in the " first position " at the metacarpo-phalangeal joint. The correlations between the two joints in the right and left thumbs of the males and females were calculated and it was found that a slight negative correlation existed in all four cases (Table V). This means that, if the maximum extension angle at the interphalangeal joint is high, the maximum extension angle at the metacarpo-phalangeal joint tends to be correspondingly smaller.

TABLE V

CORRELATIONS BETWEEN INTERPHALANGEAL AND METACARPO-PHALANGEAL JOINTS OF THE RIGHT AND LEFT THUMBS OF THE EUROPEAN GROUP

Side	Males		Females	
	r	Observations	r	Observations
Right	−0·19	133	−0·19	100
Left	−0·20	133	−0·10	100

TABLE VI

NUMBER OF SUBJECTS SHOWING AN ANGLE OF MORE THAN 40° AT THE METACARPO-PHALANGEAL JOINT IN THE "SECOND POSITION"

Sex	Right	Total examined	Left	Total examined
Male	5 (3·73%)	133	10 (7·5%)	133
Female	11 (11%)	100	18 (18%)	100

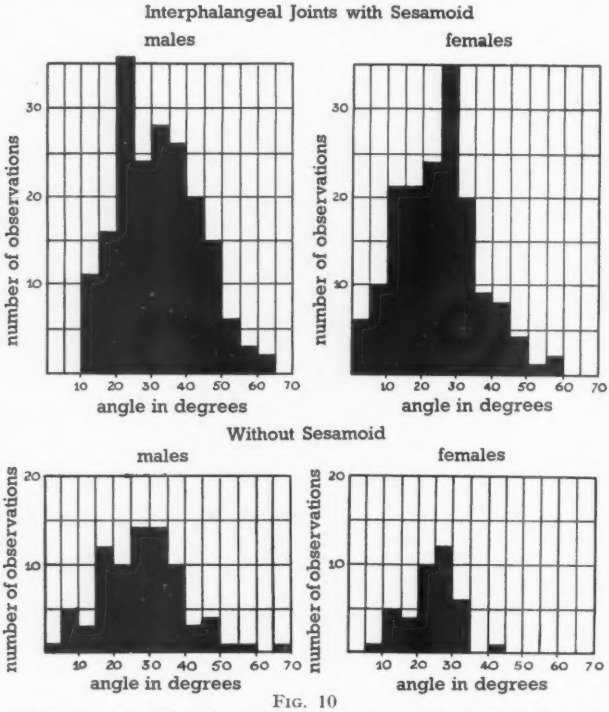

FIG. 10

Histograms of angles of maximum extension at the interphalangeal joints of males and females with and without sesamoid bone.

4) The "second position"—An examination of the films taken with the carpo-metacarpal joint in flexion showed that, although the angle at the interphalangeal joint showed no significant change from the "first position," there was sometimes a considerable increase in the angle at the metacarpo-phalangeal joint. Some of these second positions could be described as subluxations (Fig. 7). An attempt was made to select these cases by inspection of the radiographs. It was found, however, that no sharp distinction could be drawn, either from the appearances or from measurements of the metacarpo-phalangeal angles, between extreme extension of the joint and subluxation. Extreme extension, or subluxation, was seen more often in women and more often in the left hand. This is shown in Table VI, which gives the number of cases showing an angle of more than 40°. This particular angle was chosen because such a high value was never obtained in the "first position."

5) The relation between extension at the interphalangeal joint and the presence of a sesamoid bone—Figure 10 gives the histograms of the distribution of the angles at the interphalangeal joints of the thumbs in males and females with and without a sesamoid bone.

TABLE VII

MEANS AND STANDARD DEVIATIONS OF ANGLES AT THE INTERPHALANGEAL JOINTS WITH AND WITHOUT A SESAMOID BONE

Sex	With sesamoid			Without sesamoid		
	Mean	Standard deviation	Number of observations	Mean	Standard deviation	Number of observations
Male	31·80	11·40	187	28·14	12·05	79
Female	24·17	11·34	161	23·90	7·05	39

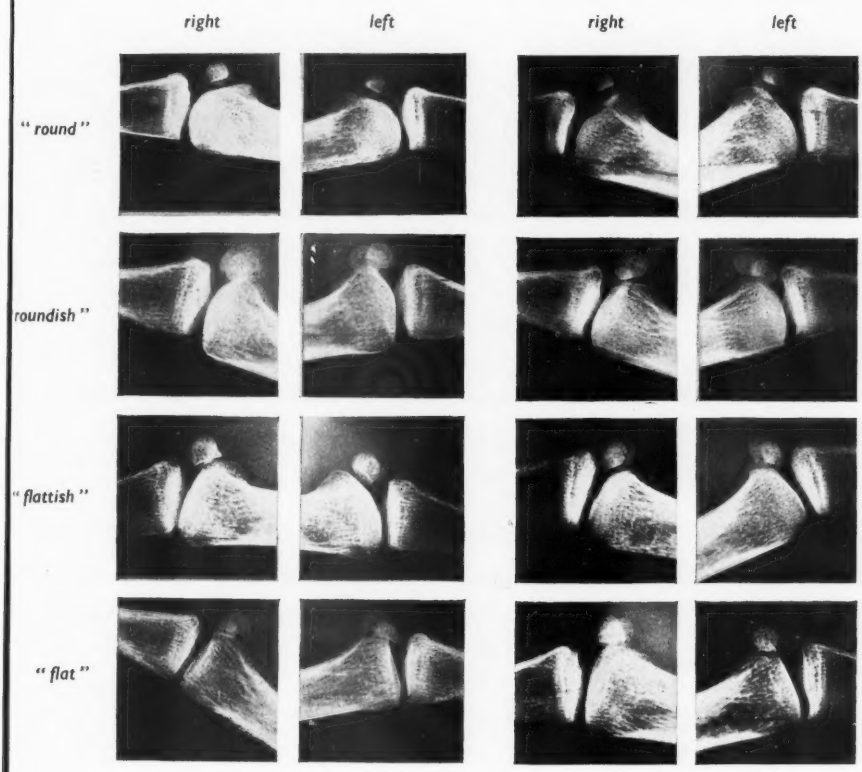

FIG. 11

Variations in the shape of the head of the first metacarpal bone.

Table VII gives the means and standard deviations of the angles with and without a sesamoid bone. The distributions are clearly very similar and the difference between the means cannot be regarded as significant.

6) Shape of the head of the metacarpal bone—The shape of the metacarpo-phalangeal joint surfaces varies considerably between " round " and " flat." It was easier to divide the joints into four groups according to the shape of the metacarpal heads: " round," " roundish," " flattish " and " flat " (Fig. 11).

FIG. 12

FIG. 13

To show the difference in range of flexion at the metacarpo-phalangeal joint when the articular surfaces are round or flat in type.

Certain conclusions can be drawn about the association between the shape of this joint and its movements:

a) The right and left thumbs usually have the same type of joint.

b) In flat joints, increased extension in the "second position" is not found.

c) A preliminary survey of flexion at the metacarpo-phalangeal joints suggests that in "flat" and "flattish" joints flexion is considerably limited (Figs. 12 and 13).

d) The combined incidence of "flat" and "flattish" joints is about 10 per cent.

7) Group of 31 male Indians compared with 133 male Europeans—Figure 14 shows histograms of the angles of maximum extension at the interphalangeal and metacarpo-phalangeal joints in the "first position" of the right and left thumbs; and Table VIII shows the means and standard deviations for these joints in the Indians. The following conclusions can be drawn:

a) As in Europeans, both joints show a considerable variation between individuals in maximum extension in the "first position," and the distribution is fairly symmetrical.

b) The means of the right and left interphalangeal joints are greater by 7·54° and 7·56° respectively in Indians than in Europeans; these differences are statistically significant.

TABLE VIII

MEAN AND STANDARD DEVIATIONS OF THE ANGLES AT THE INTERPHALANGEAL AND METACARPO-PHALANGEAL JOINTS IN THE INDIAN GROUP

Side	Mean	Standard deviation	Number of observations
Right	36·69	15·51	31
Left	39·76	11·45	31
Right	2·20	11·98	31
Left	10·08	13·68	31

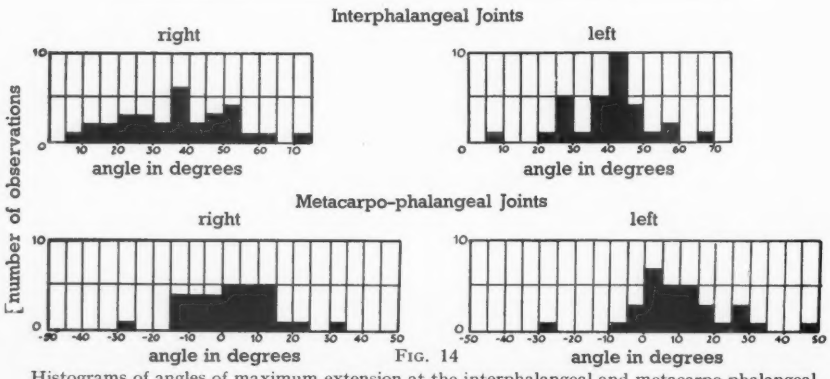

FIG. 14

Histograms of angles of maximum extension at the interphalangeal and metacarpo-phalangeal joints of the right and left thumbs in 31 male Indians.

c) The mean of the right metacarpo-phalangeal joint in Indians is 0·12° less, and the mean of the left metacarpo-phalangeal joint is 4·46° greater, than the means of the corresponding joints in Europeans; neither of these differences is significant.

d) The Indians show a significant increase in the number who have a hyperextended "second position," that is, over 40°. 16 out of 62 Indian thumbs show this as compared with 15 out of 266 European thumbs.

8) Group of 30 male Africans compared with 133 male Europeans—Figure 15 shows histograms of the angles of maximum extension at the interphalangeal and metacarpo-phalangeal joints in the "first position" of the right and left thumbs, and Table IX the means and standard deviations for these joints in Africans. The following conclusions can be drawn:

a) As in Europeans, both joints show considerable variation between individuals in maximum extension in the "first position," and the distribution is fairly symmetrical.

b) The means of the right and left interphalangeal joints are greater by 7·35° and 10·13° respectively than the corresponding means in Europeans; these differences are statistically significant. In this respect the Indians resemble the Africans.

c) The means of the angles at the right and left metacarpo-phalangeal joints in Africans are 0·15° and 0·12° respectively less than the corresponding means in Europeans; neither of these differences is significant.

d) Out of a total of 60 metacarpo-phalangeal joints there are 4 which can be grouped as hyperextensors, that is, measuring over 40° in the "second position." This proportion is much less than in Indians but similar to that found in Europeans.

TABLE IX

MEANS AND STANDARD DEVIATIONS OF THE ANGLES AT THE INTERPHALANGEAL AND METACARPO-PHALANGEAL JOINTS IN THE AFRICAN GROUP

Side	Mean	Standard deviation	Number of observations
Right	36·50	13·15	30
Left	42·33	11·45	30
Right	2·17	10·57	30
Left	5·50	9·85	30

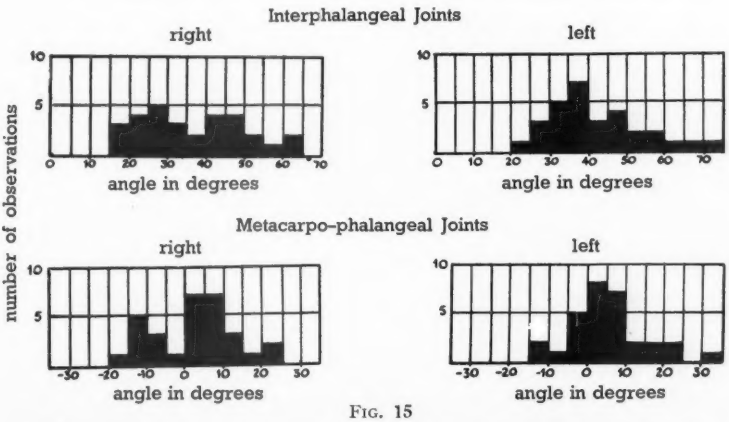

FIG. 15

Histograms of angles of maximum extension at the interphalangeal and metacarpo-phalangeal joints of the right and left thumbs in 30 male Africans.

DISCUSSION

Interphalangeal joint of the thumb—There is very wide variation in the range of extension movement in this joint. In a normal joint the range of movement is determined by the shape of the articular surfaces, by the capsule and ligaments, by the associated muscles and tendons and by the fascia and skin related to the joint. There is little variation in the shape of the articulating surfaces in different subjects, and it is probable that the observed variation is related to the capsule, to the muscles and tendons that produce the movements, or to both. If the anterior capsule is lax, more extension may occur, and clinical examination gives the impression that this is the main factor. Voluntary extension, however, may be influenced also by the ability of the flexor pollicis longus to lengthen and of the extensor pollicis longus to shorten. If this were an important factor one might have expected a change in the range of extension of the interphalangeal joint when the thumb was held in the " second position " with the carpo-metacarpal joint flexed. In most subjects, however, no such change was observed. In a few, where in the " second position " there was a very pronounced degree of extension of the metacarpo-phalangeal joint, the flexor pollicis longus was so lengthened round the front of the metacarpo-phalangeal joint that extension at the interphalangeal joint was reduced (Figs. 16 and 17). In many subjects with a large angle of extension at the interphalangeal joint of the thumb, there is evidence that the joints of the other digits can be hyperextended.

There have been many investigations and many differences of opinion on the functions of the sesamoid bones of the hand (Gillette 1872, Pfitzner 1891–92, Retterer 1918). It has been shown in this study that whatever function they may have, the presence of sesamoid bones at the interphalangeal joint of the thumb is not related to the range of extension of that joint.

Metacarpo-phalangeal joint of the thumb—Maximum extension here presents more problems. The shape of the joint surfaces is probably important in determining the range of movement at the metacarpo-phalangeal joints because on no occasion was there an increase in extension in the " second position " in a joint classified as " flat " or " flattish." On the other hand, when the metacarpal head was " round " or " roundish," increase in extension in the " second position " was often found. The term " hinge joint " in arthrology is somewhat misleading. At most joints where hinge movements take place, gliding movements also occur. If the surfaces between the bone ends are reciprocally curved, the range of movement is increased considerably. If the joint surfaces are flat, one bone is incapable of gliding round the other; it simply tilts at the front or back edges of the joint, and increased flexion or extension demands wide separation of the joint surfaces and considerable stretching of the capsule. Joints with flat surfaces are therefore associated with a limited range of movement.

The large number of muscles attached to the region of the metacarpo-phalangeal joint makes it difficult to examine their role in determining the range of extension. Only one muscle is attached near the back of the joint, namely extensor pollicis brevis. It produces extension but it is aided at full extension of the interphalangeal joint by the extensor pollicis longus. On the flexor aspect of the joint are abductor pollicis brevis, flexor pollicis brevis, the first palmar interosseous, the first dorsal interosseous, and the adductor pollicis transversus and obliquus. In full extension all these muscles are stretched and, if they were short, limited extension might be expected. A short flexor pollicis longus would also prevent full extension at this joint if the interphalangeal joint were fully extended.

The capsule may be important because a tight anterior capsule could limit extension. Another factor is the web between the thumb and index finger. If the metacarpal bone is extended fully the web is usually taut and could limit extension of the metacarpo-phalangeal joint.

FIG. 16

FIG. 17

To show that increased extension at the metacarpo-phalangeal joint may cause diminished extension at the interphalangeal joint.

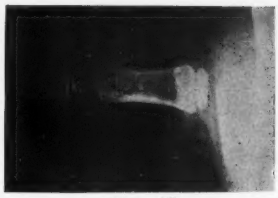

FIG. 18

A hyperextensible thumb in a child of one of the subjects.

If the carpo-metacarpal joint is flexed, further extension at the metacarpo-phalangeal joint does not usually take place. This failure to extend further must be due either to the shape of the joint surfaces or to the tightness of the anterior capsule, because the muscles in front of the joint and the web are relaxed. In a proportion of subjects with curved joint surfaces further extension does take place, and we suggest that laxity of the capsule is the reason. The degree of further extension is variable but it can amount almost to subluxation of the joint.

The word "double-jointed" is frequently used by laymen to describe individuals who can extend one or more joints excessively. No dictionary or standard text-book of anatomy, however, contains the word. It is clear that this ability to hyperextend is one of the phenomena referred to when the word "double-jointed" is used, but it is difficult to see what "double" signifies in this context. Many of the subjects were well aware of their ability to hyperextend the metacarpo-phalangeal joint of the thumb. It can be present from a very early age (Fig. 18). Most subjects said that practice had not increased the amount of extension; one said that, having recognised the trick in one hand, she had learned by practice to do it with the other. One or two remarked that the range of extension movement had decreased over a period of years.

FIG. 19

FIG. 20

FIG. 21

FIG. 22

FIG. 23

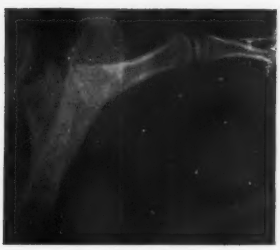

FIG. 24

To show the sequence of movements in one subject with hyperextensible thumbs.

Usually the movement was under complete voluntary control but occasionally attempts to extend the thumb fully were accompanied by sudden involuntary movement into the hyperextended position; and one subject said this tendency to subluxate occurred while spanning an octave on the piano.

The sequence of movements is initiated by flexion of the carpo-metacarpal joint by the flexor pollicis brevis, which may be accompanied by slight abduction of the metacarpal bone. The extensor pollicis longus and extensor pollicis brevis are then contracted, thus pulling the proximal phalanx into further extension. Beyond a certain point, it is the action of these muscles that produces full extension at the metacarpo-phalangeal joint (Figs. 19–24).

In a genetical and linkage study of acholuric jaundice in twenty-six families, Race (1942) noted the occurrence of hyperextensibility of the metacarpo-phalangeal joint. This he defined

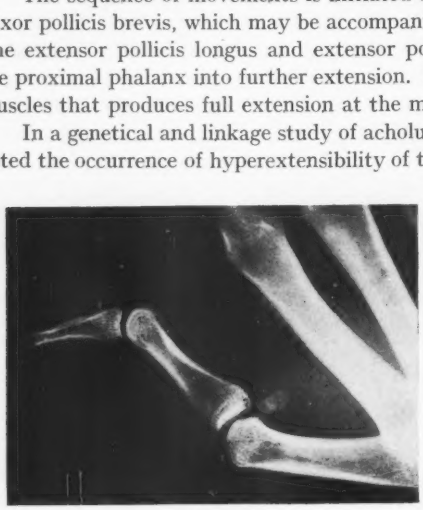

FIG. 25

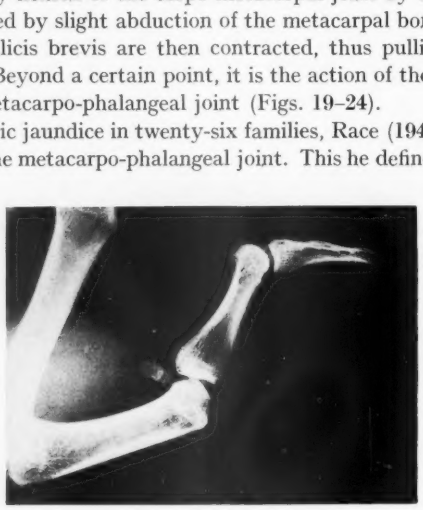

FIG. 26

A subject with marked limitation of extension at the metacarpo-phalangeal joint of each thumb. Note the peculiar shape of the metacarpal heads.

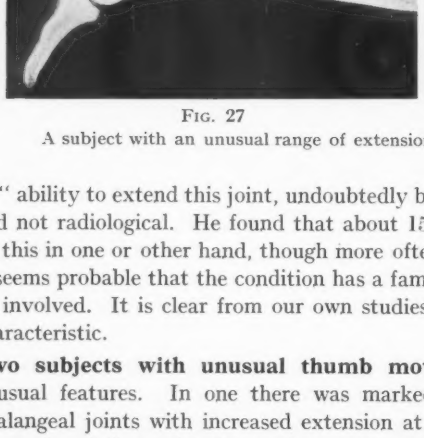

FIG. 27

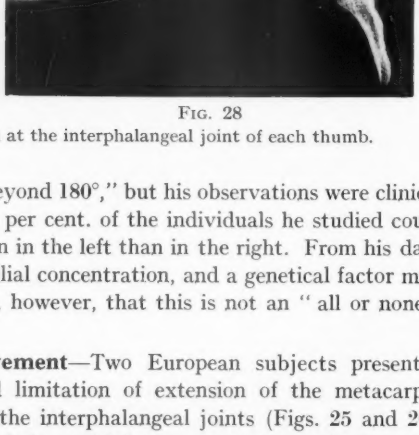

FIG. 28

A subject with an unusual range of extension at the interphalangeal joint of each thumb.

as " ability to extend this joint, undoubtedly beyond 180°," but his observations were clinical and not radiological. He found that about 15 per cent. of the individuals he studied could do this in one or other hand, though more often in the left than in the right. From his data it seems probable that the condition has a familial concentration, and a genetical factor may be involved. It is clear from our own studies, however, that this is not an " all or none " characteristic.

Two subjects with unusual thumb movement—Two European subjects presented unusual features. In one there was marked limitation of extension of the metacarpo-phalangeal joints with increased extension at the interphalangeal joints (Figs. 25 and 26). It was found that extension at the metacarpo-phalangeal joint was not increased even when the interphalangeal joint was fully flexed. The shape of the metacarpal head was peculiar. It was uneven and suggested that the articular surface did not extend in a backward direction

more than half-way, thus preventing full extension. It was also possible that the front part of the capsule was very tight. In the second subject (Figs. 27 and 28) there was an unusually marked degree of extension at the interphalangeal joint, and considerable extension at the metacarpo-phalangeal joint, but no increase in this extension in the " second position " when the carpo-metacarpal joint was flexed. Furthermore, he showed marked hyperextension of the joints of the rest of the digits. The range of extension of the joints in this European subject was comparable only to that found in three Indians.

Extension of the interphalangeal joint in Indians and Africans—The significant difference in extension at the interphalangeal joints between the Europeans on the one hand and the Indians and Africans on the other has already been commented on. It is presumed that this is due to increased laxity of the capsule. Compared with Africans a relatively large number of Indians can hyperextend their metacarpo-phalangeal joints, and in this respect the African group resembles closely the European group. The increased extension in both joints of the thumbs in Indians is very striking, and is in conformity with the general impression that Indians, who make such use of joint movement in their national dancing, have indeed more mobile hands than Europeans.

SUMMARY

1. The range of variation in full extension at the interphalangeal and metacarpo-phalangeal joints of the thumbs of 133 male and 100 female Europeans, and of 31 male Indians and 30 male Africans, has been investigated.

2. There is considerable variation between individuals in the maximum extension of both joints of the right and left thumbs in all groups studied.

3. The distribution for each joint in both thumbs in all groups is fairly symmetrical.

4. There is a high correlation between the right and left thumbs for both joints in all groups.

5. The mean angle of extension at the right and left metacarpo-phalangeal joints in all groups is similar. Female Europeans, however, show a significantly greater mean angle than male Europeans.

6. The mean interphalangeal angle of extension in male Europeans is significantly greater than that in female Europeans and the mean in the Indian and African groups is significantly greater than in the male European group.

7. There is slight negative correlation between the metacarpo-phalangeal angle and interphalangeal angle in each thumb in the European groups.

8. Many subjects in all groups can increase extension at the metacarpo-phalangeal joint after flexing the carpo-metacarpal joint. Marked hyperextension (over 40°) is more frequent in the left than in the right thumb, in females than in males, and in male Indians than in male Europeans and Africans.

9. Maximum extension at the interphalangeal joints is not related to the presence of a sesamoid bone in the anterior part of the capsule of the joint.

10. The surfaces of the metacarpo-phalangeal joints vary considerably in shape. Those which are flat form about 10 per cent. of the sample and do not show hyperextension.

11. The factors influencing the amount of extension at the interphalangeal joint is the degree of laxity of the anterior capsule. The problem at the metacarpo-phalangeal joint is more complex; both the capsule and the shape of the joint surfaces play important roles.

We wish to thank Mr P. Venning for assistance in radiography and Mr F. J. Pittock for the photographs.

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LÉRI'S PLEONOSTEOSIS, CARPAL TUNNEL COMPRESSION OF THE MEDIAN NERVES AND MORTON'S METATARSALGIA

REGINALD WATSON-JONES, LONDON, ENGLAND

There is no account in English literature of the dystrophy described by Léri as pleonosteosis (Gr. *pleon*-superabundant), which is characterised by broadening and deformity of the thumbs, flexion contracture of the fingers, thickening and stiffness of the toes, limited movement of other joints, shortness of stature and a Mongoloid facies. There are not more than twenty reports in the literature of the world, but it is difficult to believe that the incidence is represented accurately by such paucity of record. Four patients with typical contractures of the fingers and toes are described in this note. In one there was bilateral compression of the median nerves in the carpal tunnels and bilateral Morton's metatarsalgia with plantar digital neuromata. These complications of pleonosteosis have not been described before and they may be significant in the pathology of the disease.

REVIEW OF LITERATURE

The family reported by Léri included a man aged thirty-five years and the children of his second wife, a daughter aged four years and a son aged three weeks, who showed a familial and hereditary disorder which was not apparent at birth but became obvious during the first few years of life. The child by his first wife was normal.

The father measured only 5 feet 2 inches in height. His hands were broad and short, with accentuated skin creases between the thickened palmar pads. The thumbs were irregularly thickened and there was right-angled flexion deformity of the proximal interphalangeal joints of the fingers. Wrist movements were limited to a few degrees. The forearms were pronated and the elbows could not be extended fully. The arms were held slightly away from the trunk, in some internal rotation, and they could not be raised above the shoulder level. In the lower limbs there were similar though less pronounced changes, again bilateral and strictly symmetrical, with limitation of movement of the hip joints, fixed external rotation deformity, limitation of extension of the knee joints and slight genu valgum. The feet were short and " massive " and the toes broad and stiff.

Similar cases have been reported in French surgical literature (Comby 1922, Caussade and Peynet 1924, Crouzon 1924, 1929, Laroche and Barthes 1927, Rothéa 1927, Rouillard and Barreau 1927, Rousseau *et al.* 1928, Cohen and de Herdt 1928, Apert 1931, Hallé and Apert 1931, Feiguine and Tikhodéeff 1932, and Rocher *et al.* 1932, 1946, 1947). There are two reports from South America (Valentin 1939, Gareiso *et al.* 1946), but no others have been traced. The constant feature has been the curious thickening and broadening of the digits, especially the thumbs, with flexion contracture of the interphalangeal joints. Changes in the proximal joints have varied. In some there was limitation of elbow and shoulder movement, or increase in size of the femoral heads with coxa vara; in many there was slight genu valgum, one patient needing two operations for the correction of this deformity; but in others the elbow, shoulder, hip and knee joints were normal. Most, but not all, patients showed the Mongoloid facies. The influence of heredity was usually obvious, but sporadic cases were reported by Laroche and Barthes, Rocher and Roudil, and Rocher and Pesme.

Occasional features may perhaps be ignored; for example, there was evidence in one patient of congenital syphilis (Laroche and Barthes), in one of tuberculosis (Feiguine and Tikhodéeff), in two of corneal opacity (Rocher) and in two of enlargement of the sella turcica (Rocher *et al.*). Impairment of intellect was noted only by Cohen and de Herdt, and by Rocher and Roudil. In the family reported by Apert there was mental deficiency, but the diagnosis of pleonosteosis may be in doubt because although there was contracture of the fingers, all three patients suffered from delayed speech and from progressive deafness and cachexia, and they all died in childhood.

Léri was impressed by the bone changes, particularly the large epiphyses and thick metaphyses of the phalanges and metacarpals. He thought that excessive epiphysial development was the characteristic feature and that this accounted for the postural abnormality and limitation of joint movement. He was supported by Rocher and Roudil in their report of an infant who was observed for three years from the age of twenty-six days—the youngest recorded patient. The centres of ossification in the femur, tibia and tarsus corresponded at birth to those of an infant aged six to twelve months; but the centres of ossification for the metacarpal bones were unusually delayed. In other reported cases all centres of ossification appeared at the normal date (Hallé and Apert).

The short, broad, thick hands and feet, the limited extension of knees and elbows, and the fixed internal rotation of the upper limbs and external rotation of the lower limbs, suggested to Léri an atavistic return to the simian attitude. He pointed out that it was only in the third or fourth month of intra-uterine life that the limbs began to rotate so that the patella would be in front of the knee joint and the olecranon behind the elbow joint. Léri wrote: "the characteristics of pleonosteosis approach closely those of the Mongolian race—the mother of all human races—and they are indeed a reversion to an atavistic race." But the Mongols show no skeletal abnormality; not all patients with pleonosteosis have a Mongoloid facies; and many patients with advanced contracture of the fingers and toes have no deformity of the limbs and no resemblance at all to the simian attitude. Was Léri right?

CASE REPORTS

Case 1. P. L., female, aged 21 years, farm worker—Flexion deformity of the fingers of both hands was noticed in early life and increased steadily (Fig. 1). At the time of examination, in cold weather, there was a tendency to cyanosis of the hands; and it was thought that there might be slight wasting of the thenar and first dorsal interosseous muscles. Radiographs showed buttress enlargement of the seventh cervical transverse processes, and the disability was attributed to the costo-clavicular syndrome.

FIG. 1

Case 1. Flexion contracture of the proximal interphalangeal joints. Despite the normal facies, the diagnosis of pleonosteosis was established by broadening of the thumbs, similar deformities of the toes, significant changes in the proximal joints, and comparable deformities in the mother, aunt, great-aunt and great-grandmother.

Four years later it was reported that the deformities had increased, and provisional arrangements were made for exploration of the supraclavicular triangles of the neck. Further examination then disclosed features that should, no doubt, have been observed long before. There was not only flexion contraction of the proximal interphalangeal joints but also broadening of the thumbs. The toes showed similar flexion

contractures. In the shoulders and hips there was slight limitation of rotation. Examination of the patient's mother (Case 2, Mrs L., aged 53 years) disclosed that she too had broad thumbs and flexion deformity of the fingers and toes, though of less degree. The patient's aunt (Case 3, Miss G. F., aged 51 years) had flexion deformity of the interphalangeal joints of both hands and " hammer toes." Two of the patient's great-aunts and her great-grandmother had been proud of " the Bridge hand "; this referred to the family name and not to the game; they all had flexion deformity of the interphalangeal joints.

Comment—The youngest member of this family narrowly escaped exploration of the neck for excision of " the fibrous remnants of cervical ribs " but there can be little doubt that she and her maternal relatives showed, in attenuated form, the contractures and deformities characteristic of pleonosteosis. It is true that changes in the proximal joints were minimal and that, far from the facies being Mongoloid, the patient was very attractive; but we know from the literature that these features are not essential to the syndrome of pleonosteosis.

Case 4. J. D. H., male, aged 20 years, forester—*Family history*—Parents and grandparents normal. Only sister normal. No brothers.

History—He was apparently normal at birth. In childhood his schoolmates laughed because he could not point with a straight finger; and this deformity is shown in early photographs. He learned to write with a pencil held between the index and middle fingers, and in due course he graduated at a University. The deformities of fingers and thumb increased steadily.

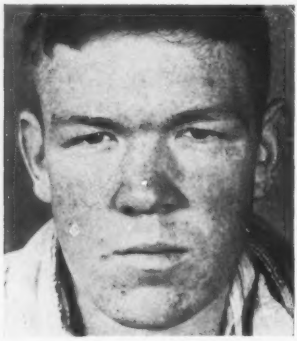

FIG. 2

FIG. 3

Case 4. The facies are Mongoloid with a broad, flat nose and typical curve at the inner canthus (Fig. 2). The toes are broad and contracted like the fingers (Fig. 3).

In recent years he had noticed numbness, tingling and pins-and-needles in the index and middle fingers of both hands. He could seldom sleep for more than six hours. After a strenuous day of harvesting or after rowing, he would wake in the early morning with intense pain in the fingers and hands. If he had been particularly energetic the pain spread up the forearms almost to the elbows.

Three years ago he noticed pain in the left fourth toe when wearing shoes. If he kept the shoe on, the pain spread; but if he took it off, the pain disappeared and he could then put it back and keep going for half an hour. Tingling and numbness were felt in the toe, and pressure under the fourth metatarsal head caused " clicking." The symptoms were worse in warm weather. There were no symptoms in the right foot.

Clinical examination—An intelligent, powerfully built man of short stature (5 feet 4 inches). Face broad and square; bridge of nose wide and flattened; eyes set apart with Mongolian curving of the upper eyelid at the inner canthus (Fig. 2). Hands short and square. Thumbs broad and thick with valgus deformity of the interphalangeal joints and slight varus deformity of the metacarpo-phalangeal joints (Figs. 4 and 5). Thenar eminences thickened with accentuation of the palmar creases (Fig. 7). *Fingers*—flexion contracture of all joints; 90 degrees at the distal joints, 40 degrees at the proximal interphalangeal joints, 30 degrees at the metacarpo-phalangeal joints; the deformity remained the same no matter what the position of the wrists, showing that the contractures were due to capsular and not tendon shortening. Radiographs showed thickening of the shafts of the metacarpals and phalanges but no significant bone deformity of the joints (Fig. 6). *Wrist joints*—thickening of periarticular tissues; dorsiflexion limited to 20 degrees and palmar-flexion to 30 degrees. Radiographs showed obliquity of the lower radial articular surface, and

FIG. 4

FIG. 5

FIG. 6

FIG. 7

Case 4. Typical case of pleonosteosis. Photographs of the left hand in full flexion (Fig. 4) and full extension (Fig. 5) demonstrate the limited movement, contracture of interphalangeal joints, and deformity of the thumb. The radiograph shows thickening of the metacarpals and phalanges but not sufficient bone change to cause joint contracture (Fig. 6). The accentuated palmar skin creases, and the limitation of supination of the forearms, are shown in Figure 7.

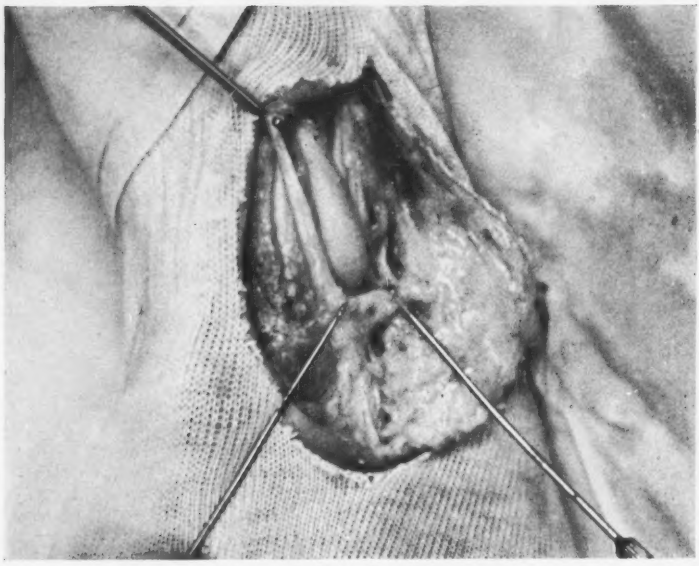

FIG. 8

Case 4. Exposure of the median nerve at the wrist joint (right). The upper hook is retracting palmaris longus. The lower hooks are at the proximal margin of the anterior carpal ligament. The median nerve is expanded to a neuroma 11 millimetres in diameter. The normal nerve above measures 7 millimetres.

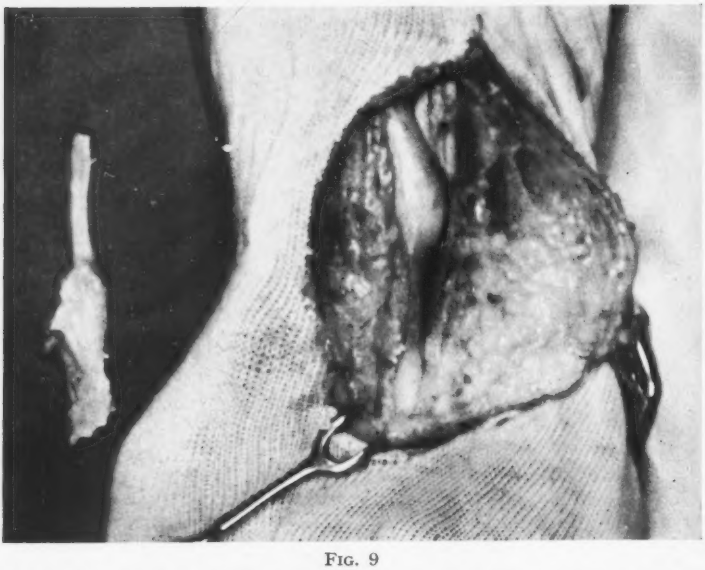

FIG. 9

Case 4. The anterior carpal ligament has been excised together with part of palmaris longus (specimen on left); it was three times its normal thickness. Beneath it the median nerve was discoloured and attenuated, measuring only 3 millimetres. The operative findings in the left wrist were identical.

slight relative shortening of the ulna, but no thickening of the joint margins, no osteophytes and no abnormality of the carpal bones. *Median nerves*—In both hands there was loss of touch and alteration in the quality of pain over most of the digital part of the median supply. No wasting or paresis of the intrinsic muscles. Sensation in the ulnar distribution normal. *Other joints of the upper limbs*—Pronation of the forearms limited to 30 degrees and supination to 40 degrees. Movement of the elbow joints normal. Shoulder joints normal except for slight limitation of external rotation. Clavicles, skull, spine and pelvis normal. *The lower limbs*—Internal rotation of the hip joints 20 degrees, external rotation 40 degrees, other movements normal. Radiographs showed wide femoral necks. Knee and ankle joints normal. *Feet*—short and broad, 9·5 inches long, 4 inches wide; the shoes were two sizes larger than needed for the length of the foot. Great toes short and thick like the thumbs; slight valgus deformity at the terminal joints. Flexion contracture of all toes, to the right-angle at the terminal interphalangeal joints (Fig. 3). Transverse arches flattened. *Plantar digital nerves*—Tenderness on pressure over the bifurcation of the digital nerve to the cleft between third and fourth toes. No neuroma felt. No objective change in sensation. *General condition*—He was seen by Sir Henry Cohen who excluded abnormality of the central nervous system, found no metabolic change on detailed blood examination, and established the diagnosis of Léri's pleonosteosis.

FIG. 10

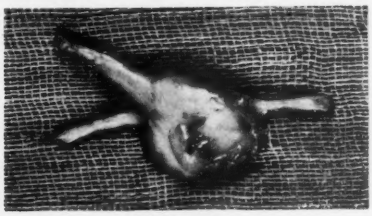

FIG. 11

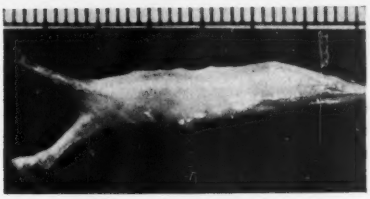

FIG. 12

Case 4. Plantar digital neuroma at the third-fourth cleft. In the right foot (Figs. 10-11) there was an eccentric neuroma with thickening of the branch to the fourth toe—to which pain was referred. The neuroma from the left foot was more diffuse (Fig. 12—scale in millimetres).

First operation, *September* 1947—*Resection of both anterior carpal ligaments with neurolysis of median nerves; excision of plantar digital neuroma (left)*—The median nerves were exposed (right, Mr Raymond King; left, R. W-J.). Immediately above each carpal tunnel the nerve was expanded over a distance of 2 centimetres to form a neuroma 11 millimetres in diameter; the normal nerve above measured 7 millimetres (Fig. 8). The anterior carpal ligament was resected. It was much tougher and three times thicker than normal. Deep to the ligament, the nerve was obviously compressed and attenuated, measuring only 3 millimetres in diameter; it had lost its normal sheen and appeared discoloured (Fig. 9). Immediately distal to the ligament, the nerve regained its normal appearance and again measured 7 millimetres.

Through a plantar incision the digital nerve to the third-fourth cleft was exposed. Just proximal to its bifurcation, and lying over the transverse ligament, was a neuroma three times the normal diameter of the nerve and almost 3 centimetres long (Fig. 12). The nerve and neuroma were excised. The plantar digital vessels were not recognised.

Second operation, *September* 1948—*Excision of plantar digital neuroma (right)*—During the previous year the patient complained increasingly of symptoms in the right foot, exactly similar to those in the left. The first attack occurred while wearing hobnail boots, and two others coincided with the first wearing of new shoes. The digital nerve to the third-fourth cleft was exposed and a neuroma was removed (Figs. 10 and 11). It was similar to the one removed previously except that it was eccentric and involved a

shorter length of nerve. It showed a fibrous swelling extending from the digital nerve itself into the branch to the fourth toe, but not to that for the third toe. This finding corresponded with the reference of pain to the fourth but not to the third toe.

Progress—Pain in the hands was relieved within a few days of the first operation but impairment of sensation persisted for twelve months before recovery was complete. In each foot, relief of pain was gained promptly after operation. Now, after two years, although the deformities of the hands and feet are the same, he does full work as a forester and often walks fifteen miles a day over peat-bogs and sand-dunes.

Pathological report (Professor Dorothy Russell, Bernhard Baron Institute of Pathology, London Hospital).

1) *Anterior carpal ligament*—The specimen consists of a strip of the palmaris longus tendon to which is attached a mass 3·8 centimetres long and 1·2 centimetres thick, of tough, grey tissue corresponding to the anterior carpal ligament. Macroscopically, it is abnormally thick. *A control specimen* measures up to 0·4 centimetres thick; this normal anterior carpal ligament is composed of closely woven bundles of rather acellular collagenous tissue containing scanty elastic fibres which collectively form a layer, up to 0·1 centimetres thick, bordering the smooth inner surface of the carpal tunnel. Superficial to this surface the collagen bundles ramify through a zone of adipose tissue which includes vessels of supply and small bundles of nerve fibres; and this layer is also intersected by bundles of stout elastic and finer collagen fibres (Fig. 13). *The pathological specimen*—The collagenous tissue is greatly increased, forming almost the whole of the section. A large proportion is actually fibrocartilage, in association with which a good deal of mucinous material is laid down both in relation to the cells and in linear deposits between the collagen fibres. There is a remarkable absence of elastic tissue in comparison with the control (Figs. 14 and 15). A small amount of skeletal muscle is attached to the surface; this shows advanced atrophy of the fibres and associated fibrosis. The tendon appears normal. There is no demonstrable vascular abnormality. Two twigs of nerve at the periphery of the specimen show early mucinous change and fibrous increase of the endoneurium.

2) *Plantar digital neuroma*—The excised portion of digital nerve forms a fusiform mass 3·7 centimetres long and up to 0·5 centimetres thick. A longitudinal section shows wide separation of the constituent nerve bundles by collagenous tissue of variable density containing evenly distributed spindle fibroblasts and small vessels, mainly arterioles and venules. There is no inflammatory cellular infiltration apart from one small group of perivascular lymphocytes. Tissue mast-cells are scattered throughout the collagenous tissue. Several of the nerve bundles appear greatly swollen from the presence of mucin, especially in the endoneurium, and from uneven fibrous thickening of this tissue and of the perineural sheaths. A few tissue mast-cells are present. In the more swollen bundles the axis-cylinders, demonstrated by Bielschowsky's method, are parallel but widely separated. The presence of occasional amoeboid macrophages suggests that some have undergone degeneration and have disappeared; but stages of this process are not demonstrable. None of the blood vessels in this preparation shows degeneration or any occlusive change.

3) *Summary*—The digital neuroma is of the ischaemic type such as may occur in cases of Volkmann's contracture, but the specimen does not provide evidence of the cause of the ischaemia. The anterior carpal ligament is greatly thickened by fibrocartilaginous alteration of the collagen. This may reasonably have produced compression and atrophy of adjacent structures. If a similar change is widely spread in other ligaments the digital neuroma might be attributable to this.

DISCUSSION

Pathology of pleonosteosis—Léri believed that the pathological basis of this disorder was premature and excessive ossification with epiphysial enlargement accounting for deformity. The title he chose leaves no doubt as to his view but it is an unfortunate title. Despite the support of Rocher and Roudil, there has been no general evidence of "precocity of ossification." Moreover, the contracture of joints has always been far greater than would be expected from the relatively limited bone change. This was evident in all four patients in this series; even in Case 4, the thickening of the metacarpals and phalanges was not associated with bone change at the joints sufficient to account for right-angled flexion deformity.

There have been no previous studies of the ligaments and capsules in pleonosteosis. The evidence now available shows that, in at least one case, there was striking change in the carpal ligaments which were short, thick, lacking in elastic fibres, and largely changed to fibrocartilage. When this is correlated with the clinical observation that the deformities were due mainly to capsular contraction, it seems possible that the primary pathological change in pleonosteosis may be in the joint ligaments, and that the bone thickening may be due to periosteal traction at their metaphysial attachments.

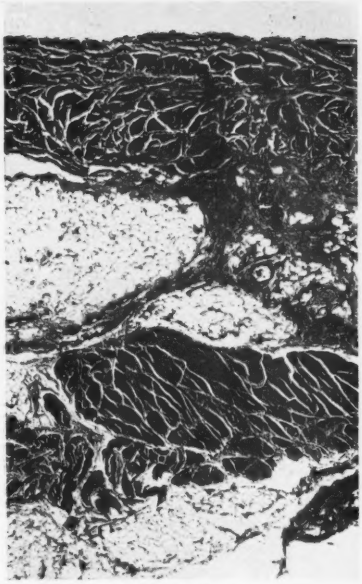

FIG. 13

Whole thickness of the anterior carpal ligament in a normal wrist, serving as control (haematoxylin and van Giesen, × 27).

FIG. 15

FIG. 14

Whole thickness of the anterior carpal ligament in Case 4 (pleonosteosis with carpal tunnel compression of median nerve). The preparation has the same magnification and is stained in the same way as in the control specimen in Figure 13 (haematoxylin and van Giesen, ×27). There is great increase in the collagenous tissue; much of it is actually fibrocartilage, which is seen in higher magnification in Figure 15 (haematoxylin and eosin, × 150).

Léri and other writers were at pains to distinguish pleonosteosis from achondroplasia which of course it does not resemble. A closer analogy could be drawn with arthrogryposis multiplex congenita, in which there are congenital and hereditary tendencies, sometimes a Mongoloid facies, and more severe joint contractures due solely to changes in the soft tissues (Middleton 1934). But we have only begun to study the pathology of this disease and many further investigations are needed.

Carpal tunnel compression of the median nerve—Injury to the median nerve at the wrist by the pressure of a dislocated bone or displaced fracture has long been recognised, and " tardy median palsy " occurring many years after fracture has been described. Recently there have been reports of compression of the nerve in a carpal tunnel that was normal, or, at least, not encroached upon by bone thickening. There are two records of nerve compression at this level in patients with acromegaly. These nerve lesions have often been grouped together, but it would be wise to differentiate them.

Acute compression by bone—The fact that median paralysis seldom complicates recent fractures of the lower end of the radius even when widely displaced, but that it often occurs when the semilunar bone is dislocated forwards, indicates the susceptibility of the nerve to compression within the confined space beneath the anterior carpal ligament.

Acute compression by haemorrhage—In 1943 this writer mentioned the case of a doctor who stopped a fast cricket ball in the palm of his hand. After two hours he felt tingling and then intense pain in the distribution of the median nerve. The lightest touch on the fingers precipitated agonising waves of pain. Aspiration of sixteen cubic centimetres of blood from the palm gave temporary relief but it was not until the anterior carpal ligament had been divided that the agony was relieved. The ligament itself was normal and there was no bone injury. The median paralysis, which recovered after several months, was due to acute compression in the tunnel by haemorrhage.

Slow compression by bone—There are many accounts of late median palsy due to compression of the nerve by displaced bone fragments, or by the osteophytes of hypertrophic arthritis from old carpal injuries. In two patients reported by Zachary (1945) the injury had been a fracture of the carpal scaphoid bone; the median paralysis recovered after section of the anterior carpal ligament by Seddon. Cannon and Love (1946) described eight patients with median neuritis due to deformities of the carpal bones from fractures sustained twenty to fifty years before. In one of the three cases reported by Newman (1948) a fracture of the scaphoid bone was complicated by median paralysis after an interval of twenty years. In these and other records the neuritis has been of ischaemic origin, due to compression of the nerve by bone thickening in the floor of the tunnel, and relieved by division of the anterior carpal ligament with decompression of the nerve. Other accounts of tardy median palsy include cases that were not true examples of carpal tunnel compression, the fracture being in the lower end of the radius (Paget 1863, Lewis and Miller 1922, Abbott and Saunders 1933).

Slow compression by occupational strain—Moersch (1938) reported one patient with no bone deformity whose median nerve paralysis was relieved by section of the ligament. Cannon and Love (1946), in their series of thirty-eight cases included three with median palsy of spontaneous origin without radiographic evidence of bone abnormality. Brain, Wright and Wilkinson (1947) described six women with bilateral median neuritis, all in the second half of life, and in all of whom the wrist bones were normal. Operative exposure showed a neuroma of the median nerve immediately proximal to the anterior carpal ligament with flattening of the nerve beneath it. Similar cases have been reported by Newman (1948) and others. Brain and Wright believed that the carpal tunnel was normal and that the palsy was due to occupational stress. They showed that, in a cadaver, pressure in the tunnel was three times greater when the wrist was fully extended than

when it was flexed, and pointed out that many household occupations were performed with an extended wrist. They surmised that postural strain alone caused pressure on the nerve, degeneration in the artery to the nerve, and oedema of the nerve which increased the pressure still more.

The influence of occupation is undoubted. The neuritis may occur in any worker " whose business entails grasping instruments for long periods or pressing them into the ball of the thumb" (Kinnear Wilson 1940). But it is unfortunate that in none of these contributions was there a pathological study of the anterior carpal ligament. Is it right to assume that simple postural strain may cause paralysis of a normal median nerve lying in a normal carpal tunnel? It would seem more likely that occupational stress and advancing age cause thickening of the anterior carpal ligament and that this is the source of compression of the nerve. The possibility gains support from Case 4 in this series.

Slow compression by thickening of the anterior carpal ligament—Case 4 shows clear evidence of compression of the median nerve by an abnormally thick carpal ligament. Two other reports may be significant. Woltman (1941) described an acromegalic patient with median paralysis which recovered after division of the anterior annular ligament. Cannon and Love (1946) reported another patient with acromegaly who gained relief from pain and paraesthesia in the median distribution of the hand by division of the ligament. Woltman said that the nerve was compressed in front of the wrist joint " by proliferation of tissues." *

It may be, of course, that carpal tunnel compression of the nerve by ligamentous thickening is peculiar to certain constitutional diseases. But before accepting the suggestion of Brain, Wright and others that simple postural strain is an additional cause of compression of the median nerve at the wrist, detailed pathological studies of the ligament whenever it is removed for tardy median palsy should be reported.

Plantar digital neuroma and metatarsalgia—In many patients, pain under the tread of the foot arising from walking or long standing, usually referred to the fourth toe but sometimes to the third or even second toes, often associated with numbness and tingling, and nearly always relieved by removing the shoe, is still being attributed to " anterior flat foot " and treated unsuccessfully by metatarsal pads and exercises. Betts (1940) demonstrated that there was fibrous swelling of the digital nerve and that the symptoms were relieved by resecting the neuroma. In a recent study, Nissen (1948) in collaboration with Holmes, showed that the nerve lesion is ischaemic in nature and that severe degenerative changes in the digital artery precede the marked increase of connective tissue that provides the main bulk of the nerve expansion.

The typical neuromata removed from the digital nerves to the third-fourth cleft in each foot of Case 4 may have been coincidental, or due to no more than that the contracted toes were associated with flattening of the transverse arches with consequent weight-bearing injury to the digital arteries and nerves. But there is evidence to show that the digital neuritis of metatarsalgia is not related to transverse flat foot or to weight-bearing injury. The primary lesion is certainly in the digital artery. Nissen (1948) indicated the importance of the narrow fibrous tunnel at the proximal margin of the transverse metatarsal ligament through which the digital artery must pass to enter the cleft. It is not yet known why the digital artery to the third-fourth cleft should so often show the degenerative change, or why a similar lesion should arise less commonly in other clefts. But Nissen's observations indicate that the vascular supply to the plantar digital nerves should be studied in more detail. In Case 4 it seems possible that the ischaemic nerve lesions in the feet were due to compression of the digital arteries by abnormal plantar ligaments, comparable to the proved compression of the median nerves by abnormal carpal ligaments.

* In acromegaly there may also be plantar digital neuritis with neuroma formation (Nissen—personal communication).

SUMMARY

1. Léri's pleonosteosis is characterised by broadening and deformity of the thumbs and great toes, flexion contracture of the interphalangeal joints, limited movement of other joints, and often a Mongoloid facies. Four such cases are described.

2. A review of the twenty reports in the literature, and the cases now described, shows that the deformities are due to capsular contracture rather than deformity of bone.

3. In one patient there was striking evidence of fibro-cartilaginous thickening of the anterior carpal ligaments. It is suggested that the primary pathological change in pleonosteosis may be in the joint capsules rather than in the epiphyses.

4. The patient with thickening of the anterior carpal ligaments had bilateral median palsy from carpal tunnel compression.

5. The causes of carpal tunnel compression of the median nerve are reviewed. Acute compression may be due not only to dislocation of the semilunar bone but to haemorrhage in the palm. Late compression by bone may occur twenty to fifty years after injury. Late compression without bone abnormality has been attributed to occupational stress, but it is suggested that pathological thickening of the anterior carpal ligament may be the cause.

6. The patient with pleonosteosis and bilateral median palsy had also bilateral Morton's metatarsalgia with large digital neuromata.

7. Plantar digital neuritis has already been shown to be an ischaemic nerve lesion preceded by degenerative changes in the digital artery. The significance of the fibrous tunnel through which the artery passes to reach the digital cleft is considered.

I am grateful to Professor Dorothy Russell for her co-operation; to Sir Henry Cohen whose aid in Case 4 was invaluable; to Mr Raymond King and my other colleagues at the London Hospital; and to Mr Ruddick, clinical photographer, and Mr John King who prepared the micro-photographs.

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EXCISION OF THE CARPAL SCAPHOID FOR UNUNITED FRACTURE

F. C. DWYER, LIVERPOOL, ENGLAND *

During the last twenty years great progress has been made in the diagnosis and treatment of fractures of the carpal scaphoid. Formerly non-union was the accepted end-result (Jones and Lovett 1923), but union by bone is now obtained in a high proportion of recent fractures. Nevertheless, non-union is still common. Most cases are discovered by chance or because the patient has a second injury. Certainly many patients with non-union have performed strenuous work for many years with nothing more than vague discomfort, and the accidental discovery of non-union does not demand special treatment. It must, however, be regarded as a potential source of trouble for two reasons: first, because of the almost inevitable development of osteoarthritic changes; and second, and far more important, because of the disastrous effects that often follow a further injury, particularly if arthritic changes are already present. The aggravated traumatic arthritis is seldom relieved by conservative treatment and the capacity of the patient for work may be greatly and permanently diminished.

Several observers have reported the results of total excision of the scaphoid (Böhler 1929, Aleman 1937–38, Soto-Hall 1948), but the relatively small numbers of cases left no margin to allow for the possibility of unfortunate selection. Hirsch (1935) reported favourably on nine patients, and Davidson and Horwitz (1938) were equally satisfied with the results of eight. All these observers believed that the operation should be done before the development of arthritis, but it must be remembered that arthritic changes are often present when the non-union is first recognised. We consider that total excision of the ununited scaphoid is of considerable value in selected cases.

TREATMENT OF NON-UNION BY TOTAL EXCISION OF THE SCAPHOID

This paper reports the end-results in nineteen patients who were treated by total excision of the bone. With two exceptions the disabling symptoms had been caused by a second injury. In all of them rest and physiotherapy had been tried without success. Of the nineteen patients, seventeen have been examined recently by the writer and two have replied to detailed questionnaires. One woman who was operated on by another surgeon thirteen years ago is included because the operation was performed only six months after the initial injury; in the other eighteen, all personal cases, eighteen months was the shortest intervening period. Seventeen patients were men and two were women. The average age at the time of operation was thirty-two years, the youngest being nineteen and the oldest fifty-one years. Excision was performed thirteen years ago in one patient, five to seven years ago in ten patients, and one to five years ago in eight patients.

Technique of the operation—A straight incision is made over the anatomical snuff box. The radial vessels and branches of the radial nerve are retracted and the capsular tissues are dissected off the dorsal aspect of the scaphoid. The bone is excised after careful division of the interosseous ligaments by a tenotomy knife and without any unnecessary use of elevators. The structures attached to the tuberosity are best dissected off at an early stage and a preliminary incision over the palmar aspect of the wrist may be used for this purpose. Forcible removal of the bone, causing damage to adjacent articular surfaces and stretching of ligaments, may be responsible for some of the disappointing results that have occurred after this operation.

Excision of the radial styloid process—The *tip* of the styloid process was excised in several patients and this should be done in every instance where there is marked arthritic "pointing."

* *Paper read at the Bristol meeting of the British Orthopaedic Association, October* 1949.

This opinion is supported by the findings of Barnard and Stubbins (1948). It was noted, however, that the end of the styloid process gradually becomes rounded of its own accord after excision of the scaphoid (Figs. 1 and 2). The wide excision of the radial styloid advocated by Barnard and Stubbins is contra-indicated when the scaphoid bone is also being excised because instability of the wrist joint may result.

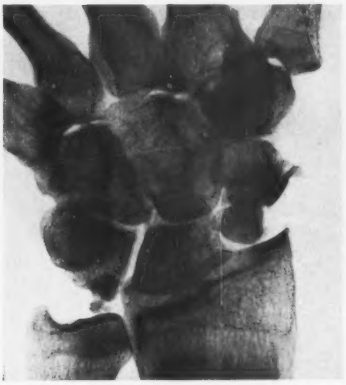

FIG. 1

FIG. 2

A patient aged fifty years complained of severe pain after a recent injury to the wrist. Figure 1 shows the old ununited fracture of the scaphoid, "pointing" of the radial styloid process and general arthritis. The lateral view showed forward sliding of the semilunar. Figure 2 is the radiograph five years after complete excision of the scaphoid. The radial styloid process, which was not excised in this case, has rounded off. There is no radial deviation of the wrist. Full movements were regained.

FIG. 3

FIG. 4

Patient aged twenty-seven years. The proximal pole of the scaphoid bone had been removed eighteen months previously. There was persistent pain and disability. Figure 4 shows the same case six years after excision of the distal fragment of the bone. No arthritis has developed. Movements are full and the patient is doing strenuous work.

After-treatment—The wrist joint is immobilised on a short cock-up splint until all signs of irritation have subsided, usually after four to seven weeks. There is certainly nothing to be gained from encouraging movement too early. When movements are begun, progress is rapid, and most patients return to light work within two to four months.

Excision of the proximal fragment only—There are several reasons for opposing this method of treatment. The operation is difficult and may cause damage to the surrounding articular surfaces and ligaments; after removal of the proximal pole, the sharp edge of the distal fragment impinges against the lower end of the radius; and arthritic changes in cases of non-union usually appear first between the radial styloid and the *distal* fragment. It seems irrational therefore to retain the distal fragment (Figs. 3 and 4). In this series, one patient who had been treated by excision of the proximal pole gained relief only after excision was completed. In another patient the proximal pole was overlooked, yet the final result was " good " (Figs. 5 and 6).

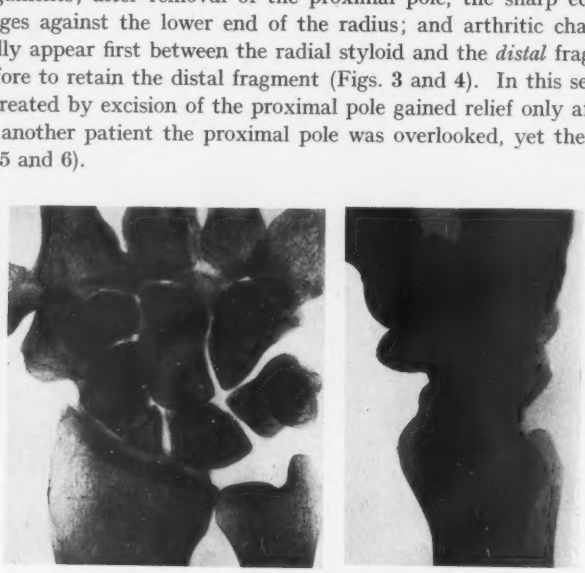

FIG. 5

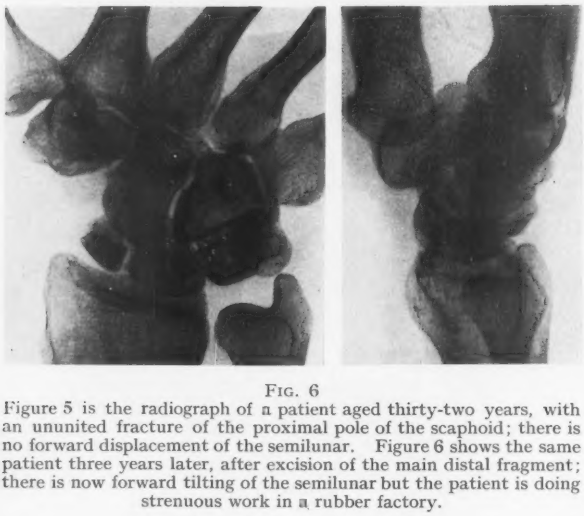

FIG. 6

Figure 5 is the radiograph of a patient aged thirty-two years, with an ununited fracture of the proximal pole of the scaphoid; there is no forward displacement of the semilunar. Figure 6 shows the same patient three years later, after excision of the main distal fragment; there is now forward tilting of the semilunar but the patient is doing strenuous work in a rubber factory.

Three factors concerned in the late results of total excision—1) *The age of the patient*—The worst results were in patients over the age of forty years with established arthritic changes, but in the same group there were just as many with remarkably good results. It is difficult to account for such variation in a similar group of patients.

2) *Clinical evidence of arthritis*—Disappointing results are likely to occur in patients of any age who show marked thickening on the dorsal aspect of the wrist joint and arthritic lipping

between the os magnum, semilunar and radius (Fig. 7). In such cases dorsiflexion tends to remain limited and pain may persist over the dorsum.

3) *Subluxation of the os magnum and semilunar*—Posterior displacement of the head of the os magnum, as if there had been an incomplete perilunar subluxation, is also unfavourable (Fig. 8). In long standing cases there is a tendency for the semilunar to displace forwards with attenuation of its posterior part. This has been noted by other observers (Aleman 1937–38, Hirsch 1935, and Lambrinudi 1943). It may well be that in all these cases the original injury was in fact an incomplete perilunar transcarpal dislocation, spontaneously reduced but nevertheless associated with tearing of the interosseous ligaments. It may also be that such ligamentous damage is an important cause of non-union of the fracture.

To summarise, the result of excision should be good when the unfavourable factors just mentioned are absent. Even when there is doubt, nothing is lost and much may be gained by " trial " excision. If this fails, arthrodesis is no more difficult and may be even more certain, because there is a large space into which bone chips can be packed after excision of the scar tissue.

TABLE I

Age at time of operation	Number	Very good	Good	Fair	Bad
40–50 years	7	—	3	1	3
30–40 years	3	—	2	1	—
20–30 years	9	3	4	2	—
Totals	19	3	9	4	3

Very good . Practically full movement, no pain, capable of strenuous work.
Good . . Able to handle tools of all kinds and perform fairly strenuous wrist work, for example joinery.
Fair . . Pain when using tools, but capable of light work.
Bad . . Complaining a good deal and fit for very light work only.

ANALYSIS OF RESULTS

The results are analysed in relation to three age groups.

1) *Age 40 to 50 years—seven patients*—In all these, the fractures were old; there was marked arthritis and movements were limited. All had sustained a recent injury and complained of severe pain. Three results were " good " and the patients could use their wrists strenuously and had little or no pain; two had a full range of movement five and six years after operation (Figs. 1 and 2). Three patients were not improved and were classified as " bad " results (Figs. 7 and 8). In one an arthrodesis has since been performed while the other two are doing light work. The remaining patient in this group, though improved, was classified as " fair " only.

2) *Age 30 to 40 years—three patients*—In one, there was arthritic lipping between the posterior margin of the radius and the semilunar; the result three years later was only " fair." The other two were operated on five and seven years ago respectively; there was minimal arthritis and the results were " good " with no evidence of deterioration.

3) *Age 20 to 30 years—nine patients*—In all of these, arthritic changes were either absent or moderate. Two patients who have not been examined clinically were classified as " fair " because they were still complaining of symptoms of moderate degree; one was still in the Army four years after operation, and the other was doing factory work. In the other seven patients the results were either " good " or " very good." In one man, the proximal pole of the

FIG. 7

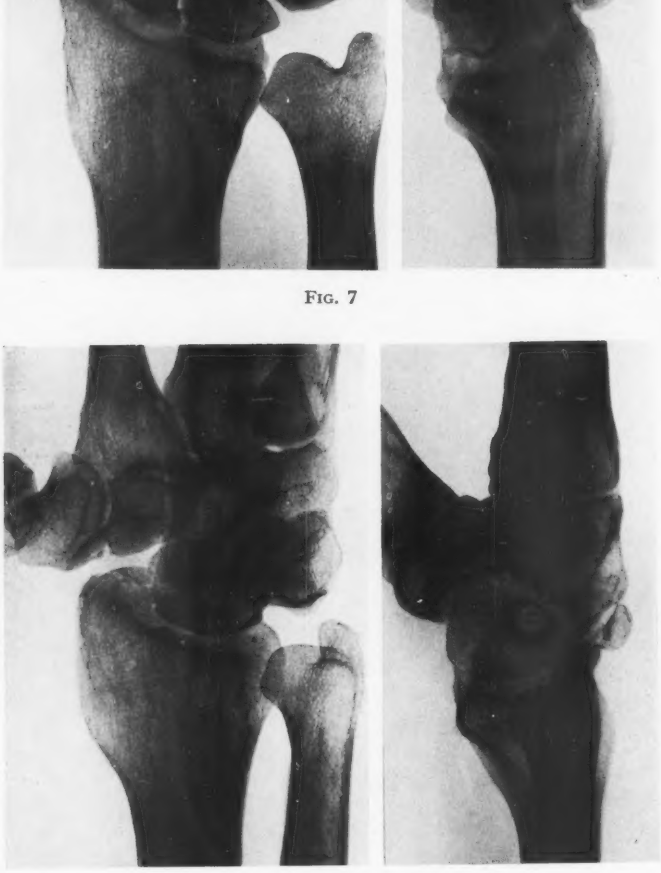

FIG. 8

Figure 7 shows the radiographs of a patient, aged forty-two years, with an ununited fracture of the scaphoid. Note the arthritic changes on the dorsal and radial aspects of the joint, and also the posterior subluxation of the head of the os magnum. Figure 8 shows the radiograph four years after complete excision of the scaphoid. This gave a "bad" result. The patient is doing light work in a coal mine.

scaphoid had been excised but pain and disability persisted until the remaining part of the bone was excised two years later (Figs. 3 and 4); since then he has worked as a milk roundsman with nothing more than aching in cold weather and some weakness. In another case a bone graft had been performed eighteen months before the excision. Of the three patients classified

as " very good," one was the woman already mentioned who had been operated on thirteen years ago, and two were engaged in very heavy occupations five and six years after operation.

Late results and late displacement of the semilunar—No deterioration of the wrist joints appears to have taken place in any patient after operation. In three, the condition was much improved by manipulation. Late radiographs show that in some cases there had been progressive forward displacement of the semilunar bone (Figs. 5 and 6); but this displacement was also present in several patients before operation and its significance is not quite clear. As the semilunar slides forward, the head of the os magnum and the posterior margin of the radius come into close contact and this may possibly lead to local arthritic changes.

Movements of the wrist joint after excision of the scaphoid—All patients suffered from some degree of stiffness before operation; in none were movements affected adversely but in the four patients with bad results there was no improvement. Four patients regained practically full movement and in the remaining eleven the range was improved. Maximal recovery sometimes took a year or more. Radial deviation of the hand was not seen and radiographs taken after several years show the wide gap still present at the site of excision (Figs. 2, 4).

CONCLUSIONS

1. The late results in nineteen cases of total excision of the carpal scaphoid bone for ununited fracture have been reviewed.

2. The results are least satisfactory when there is clinical evidence of arthritis on the dorsal aspect of the wrist, or subluxation of the os magnum and semilunar. In other cases good results usually can be expected.

3. The operation must be done carefully without injury to the neighbouring bones and ligaments. Total excision is preferable to excision of the proximal pole alone.

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PRONATION INJURIES OF THE FOREARM

with Special Reference to the Anterior Monteggia Fracture

E. MERVYN EVANS, BIRMINGHAM, ENGLAND

From the Birmingham Accident Hospital

The exact mechanism of an injury is often difficult to determine. A patient with a severe fracture of the forearm is seldom able to give precise details of his accident, and the mechanism of many such fractures is thus still unknown. Why, for instance, should one child sustain a greenstick fracture of the lower ends of the radius and ulna, another a separation of the epiphysis of the head of the radius, and yet another a supracondylar fracture of the humerus, all from apparently similar falls on the outstretched hand? The answer surely must be that a number of other factors are involved, such as the position of the elbow at the time of impact, the direction in which the body is falling, and so on.

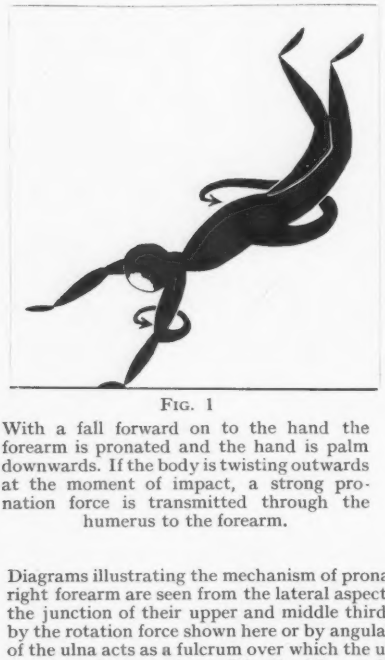
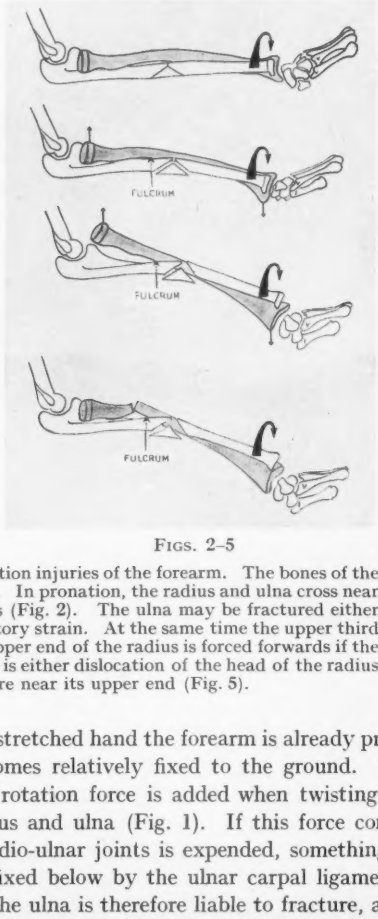


FIG. 1

With a fall forward on to the hand the forearm is pronated and the hand is palm downwards. If the body is twisting outwards at the moment of impact, a strong pronation force is transmitted through the humerus to the forearm.



FIGS. 2–5

Diagrams illustrating the mechanism of pronation injuries of the forearm. The bones of the right forearm are seen from the lateral aspect. In pronation, the radius and ulna cross near the junction of their upper and middle thirds (Fig. 2). The ulna may be fractured either by the rotation force shown here or by angulatory strain. At the same time the upper third of the ulna acts as a fulcrum over which the upper end of the radius is forced forwards if the pronation force continues (Fig. 3). The result is either dislocation of the head of the radius (Fig. 4) or a transverse fracture near its upper end (Fig. 5).

When a patient falls forward on to the outstretched hand the forearm is already pronated and at the moment of impact the hand becomes relatively fixed to the ground. To the downward momentum of the falling body a rotation force is added when twisting of the trunk causes external rotation of the humerus and ulna (Fig. 1). If this force continues until the normal range of pronation at the radio-ulnar joints is expended, something must give. The ulna cannot rotate, because it is fixed below by the ulnar carpal ligament and above by its articulation with the humerus. The ulna is therefore liable to fracture, and the combination of the rotation force and of the bending force set up by longitudinal compression

may produce an oblique, transverse or butterfly fracture in accordance with the principles set out by Messerer (Figs. 2 to 5). At the same time the radius is forced into extreme pronation and lies across the ulna, at the junction of the upper and middle thirds. As the ulna fractures, the two bones come into contact, and the point of contact forms a fulcrum over which the upper end of the radius is forced forward. As the pronation force continues, the radius is either levered forward out of the superior radio-ulnar joint or is fractured in its upper third.

On theoretical grounds, then, one would expect forced pronation to cause one of three injuries, all of which are well-known: 1) fracture of the ulna in its middle third with backward angulation and anterior dislocation of the head of the radius—the anterior Monteggia fracture; occasionally the head or epiphysis of the radius is damaged at the same time; 2) fracture of the ulna as above with a high fracture of the shaft of the radius; 3) anterior dislocation of the head of the radius without fracture of the ulna.

THE ANTERIOR MONTEGGIA FRACTURE

Although forced pronation may cause any of the injuries mentioned, and probably others (Fitzgerald 1947), this paper is concerned mainly with the anterior Monteggia fracture, the treatment of which has long been considered difficult (Fig. 6). Watson-Jones (1943) stated that it caused permanent disability in 95 per cent. of adults in a series of cases treated by many surgeons and gave a formidable list of complications. He advised open reduction and plating of the ulna with post-operative fixation in a plaster spica.

Closed reduction and immobilisation in supination have been mentioned in the literature by several authors. Speed and Boyd (1940) advocated plating of the ulna with repair of the superior radio-ulnar dislocation by a fascial sling, but they stated that in children and sometimes in adults the injury might be reduced by manipulation. In such cases they advise supination "to relax the biceps and supinator muscles and so diminish the upward pull of the biceps on the radial head and the radial pull on the ulna by the supinator." Wise (1941) reported a case of lateral dislocation of the head of the radius with fracture of the ulna treated by open reduction and noted that the dislocation was reduced by traction and supination. Consistently good results by closed methods have been reported only by Naylor (1942) who advocated traction and pronation with the elbow flexed 90 degrees and, if this failed, traction in flexion and supination. Nevertheless the primary importance of supination has not been emphasized up to the present.

FIG. 6

An old case of Monteggia fracture illustrating non-union of the ulna and anterior dislocation of the head of the radius with a plaque of calcification.

Mechanism—Most authorities consider the injury is due to a direct blow on the back of the forearm which fractures the ulna at the point of impact and forces the head of the radius forward. While it is possible that this may sometimes occur, there are several reasons for believing it to be exceptional:

1) At the site of fracture the ulna is subcutaneous and, if the fracture were due to direct violence, one would expect to find severe bruising or breaking of the skin at the point of impact. In no case in the present series was this so; one case was indeed compound, but the ulna had penetrated the skin anteriorly well away from the supposed point of impact. In support of his belief that the injury is due to direct violence, Naylor stated that there was considerable bruising at the site of the ulnar fracture which in a large proportion of cases was said to be compound. Nevertheless in the only case of compound fracture reported in detail in

his review the wound was also on the anterior aspect of the forearm. Figure 7 is a photograph of a patient taken on admission; the skin over the ulna is unmarked.

2) If the fracture of the ulna were due to direct violence one would expect more comminution than is usually seen. In the Monteggia fractures reported here the pattern of the fracture was that which one would expect from either a rotation strain or from a longitudinal compression force; in no case was the fracture comminuted.

3) When patients have given a clear history of a blow on the back of the forearm, the injury sustained has been either a fracture of the shaft of the ulna or fractures of the shafts of both bones at roughly the same level, but in no case a forward dislocation of the head of the radius.

4) Finally, dissected specimens show clearly that the capsule of the superior radio-ulnar joint is strong anteriorly and is protected by the supinator brevis and brachialis muscles. It seems unlikely that a direct blow would be sufficient to cause dislocation, especially if some of the force were spent in fracturing the ulna; a twisting force, increased by leverage action as the radius crosses the ulna in pronation, would be much more likely to do so.

FIG. 7

A child with a Monteggia fracture photographed soon after admission to hospital. Note the prominence caused by the displaced radial head. The skin over the ulnar fracture is unmarked.

FIG. 8

The radiograph of an anterior Monteggia type of fracture in a child, showing backward tilting of the head of the radius with the forearm in neutral rotation.

Confirmatory evidence of the mechanism of the Monteggia fracture is shown in the case illustrated in Figure 8. The lateral view of the forearm in neutral rotation shows tilting of the epiphysis of the head of the radius in addition to anterior dislocation. It is well known that such epiphysial displacements are caused by the head of the radius striking the capitellum while a valgus strain is being thrown on the joint, and that the epiphysis always tilts *laterally*. Here in neutral rotation the epiphysis is tilted backward, indicating that the radius has been externally rotated through 90 degrees from the position of full pronation at the moment of injury.

TABLE I

RESULTS OF PRONATION STRAIN ON THE FOREARM IN EIGHTEEN SPECIMENS

12 cases	Fracture of the ulna in its middle third and anterior dislocation of the head of the radius (the anterior Monteggia fracture)
3 cases	Fracture of the ulna in its middle third and transverse fracture of the radius just below the tuberosity
2 cases	Anterior dislocation of the head of the radius without fracture of the ulna
1 case	Dislocation of the elbow

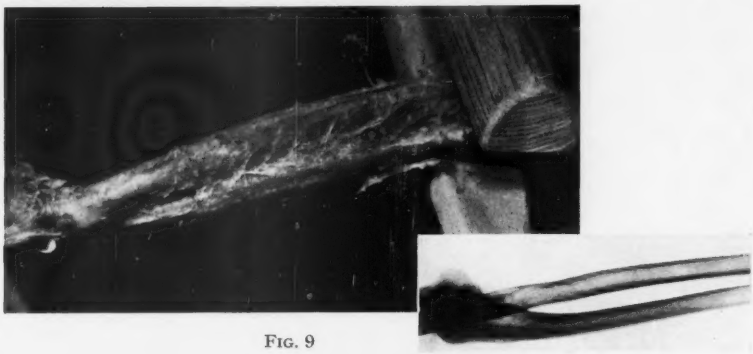


FIG. 9

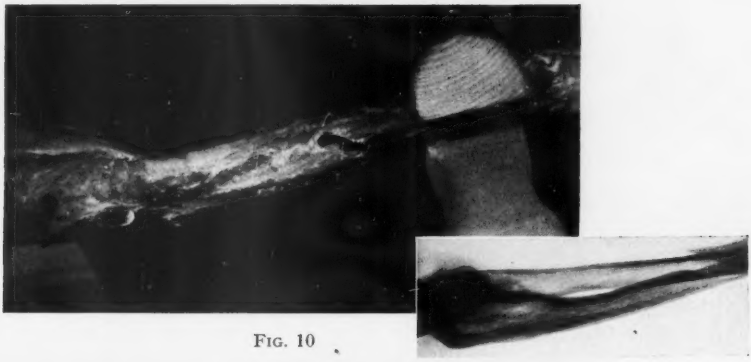


FIG. 10

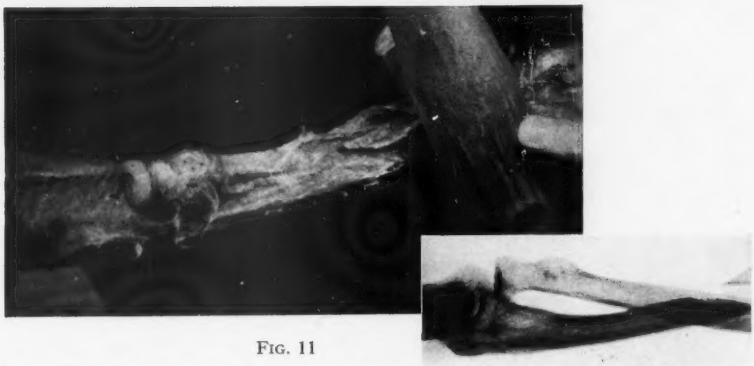


FIG. 11

Experimental production of the Monteggia type of fracture-dislocation by pronation force. In Figure 9 the limit of normal pronation has been reached. Further rotation (Fig. 10) caused a spiral fracture of the ulna and incomplete rupture of the orbicular ligament. Figure 11 shows the forward dislocation completed.

Experimental work—In an attempt to determine the mechanism of the anterior Monteggia fracture, experiments were carried out on eighteen dissecting-room specimens. The procedure was as follows: the soft tissues were removed from the elbow and forearm, leaving only the capsule and ligaments and the interosseous membrane; the shaft of the humerus was held firmly in a vice and the forearm was gripped in a wooden clamp just above the wrist and slowly pronated. A typical experiment is shown in Figures 9 to 11 and the results are shown in Table I.

In the twelve cases in which a Monteggia fracture was produced, it was interesting to find that the ulna always fractured first and as pronation continued the head of the radius was screwed forward out of its joint. The capsule began to rupture slowly strand by strand and then suddenly split, allowing the dislocation to become complete.

If these injuries are caused by a pronation force one would expect reduction to be achieved by supination. This was observed consistently in the experiments (Figs. 12–13). Whether the ulna was fractured or not, the head of the radius was reduced by supination—it was " screwed out " in pronation and " screwed home " in supination.

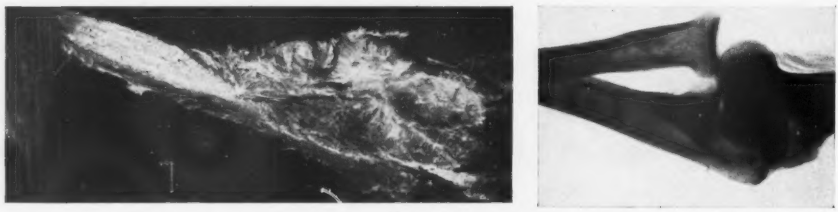


FIG. 12

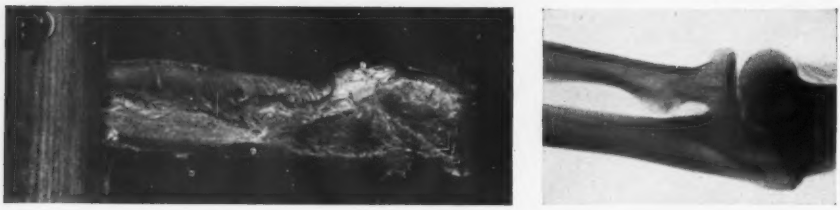


FIG. 13

In this experiment pronation caused dislocation of the head of the radius without fracture of the ulna. Figure 12 shows the specimen in pronation with the radial head dislocated. By supinating the forearm the dislocation was easily reduced (Fig. 13).

CLINICAL MATERIAL

Monteggia fractures are uncommon and in the last two years the author has been able to collect only eleven. This gives an incidence which corresponds roughly with that reported by Naylor. The investigation and management of these cases were as follows: Under general anaesthesia and with the patient lying supine the arm was held abducted at the shoulder and the elbow flexed 90 degrees. Lateral radiographs of the forearm were taken in supination, mid-rotation and pronation. In most patients full supination reduced both the superior radio-ulnar dislocation and the deformity of the ulna; with one exception reduction was most nearly complete in supination. When necessary, reduction was completed by traction on the hand and direct pressure over the radial head. After reduction had been secured an above-elbow plaster was applied and the final position was confirmed radiographically. At the end of treatment the elbow was radiographed in three rotational positions to assess the stability of the superior radio-ulnar joint. The results are summarised in Table II and illustrative cases are shown in Figures 14 to 32.

TABLE II

A SUMMARY OF ELEVEN CASES OF PRONATION INJURY OF THE FOREARM

Case	Age	Injury	Mechanism	Reduction	Result	Range of Rotation	
						Normal side (Supination / Pronation)	Injured side (Pronation / Supination)
1 V. C.	49	Simple Monteggia	Unknown	Supination	Union of ulna. Radio-ulnar joint stable	105 60	30 95
2 . P.	17	Simple Monteggia	Fell from a tram. Exact mechanism unknown	Supination	Union of ulna. Radio-ulnar joint stable	95 50	45 90
3 . J.	62	Simple Monteggia	Knocked down by car. Fell on to outstretched hand	Supination and pressure	Union of ulna. Radio-ulnar joint stable	90 40	10 90
4 . W.	8	Simple Monteggia	Fell off bicycle on to outstretched hand	Open reduction at two weeks and supination	Union of ulna. Radio-ulnar subluxation	100 50	30 100
5 . M.	5	Simple Monteggia	Fell off bicycle. Exact mechanism unknown	Neutral rotation and pressure on head of radius	Union of ulna. Radio-ulnar joint stable	Full	Full
6 . G.	7	Compound from within. Monteggia	Fell at play. Mechanism unknown	Supination	Union of ulna. Radio-ulnar joint stable	120 70	70 120
7	6	Simple Monteggia	Unknown	Supination	Union of ulna. Radio-ulnar joint stable	Full	Full
8 . M.	71	Fracture lower third radius. Superior radio-ulnar dislocation	Fell on to hand. Mechanism unknown	Radius plated. Radio-ulnar reduction in full supination	Union of radius. Radio-ulnar joint stable	100 60	50 100
9 . P.	5	Anterior dislocation head of radius	Unknown	Supination	Stable	Full	Full
10 V.	10	Separation upper radial epiphysis and anterior dislocation superior radio-ulnar joint	Caught sleeve in machine: hand rotated into full pronation and body twisted round several times	Open reduction in full supination	Stable	100 60	−50 100
1 . J.	3	Simple Monteggia	Unknown	Supination	Union of ulna. Radio-ulnar joint stable	Full	Full

The ranges of rotation movement are shown as one would see them when examining a patient. The measurements were taken with Patrick's goniometer, but mid-rotation is recorded as 0 degrees.

FIG. 14

FIG. 15

FIG. 16

Case 1. W. C., aged forty-nine years. Fracture of the ulna with anterior dislocation of the head of the radius. Figure 14 shows the position in full pronation and Figure 15 in mid-rotation. Reduction was secured only after full supination with long-axis traction (Figure 16). Note how the ulnar fragments fell together in this position.

FIG. 17

FIG. 18

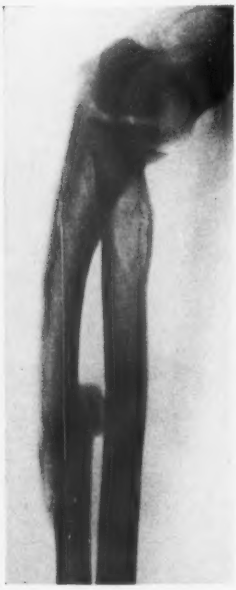


FIG. 19

Case 1, *continued*. Eight weeks later the fracture was united and the superior radio-ulnar joint was stable in all positions of rotation: Figure 17, full pronation; Figure 18, mid-rotation; Figure 19, full supination.

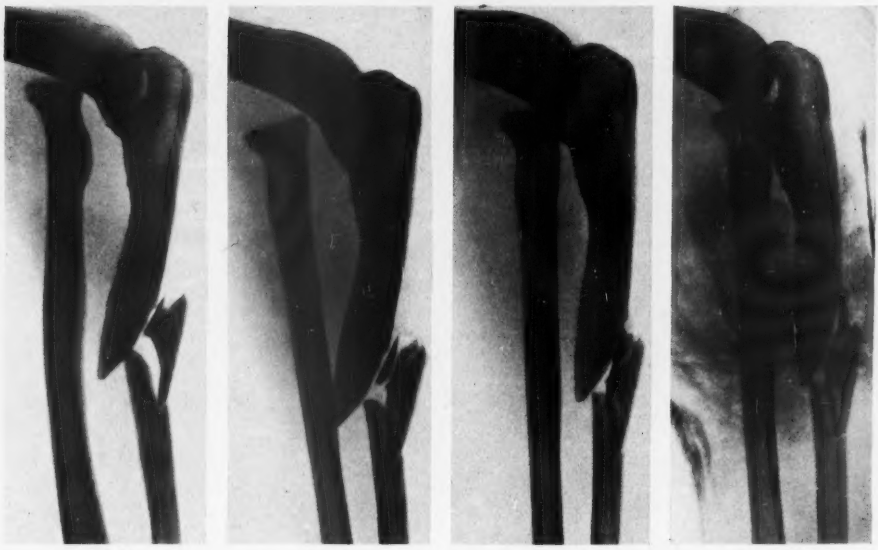


FIG. 20 FIG. 21 FIG. 22 FIG. 23

Case 3. F. J., aged sixty-two years. Anterior Monteggia fracture with maximal displacement of the head of the radius in full pronation (Fig. 20). Full supination (Fig. 21), even with long axis-traction (Fig. 22), failed to achieve reduction, but with direct pressure on the head of the radius reduction was completed (Fig.23). In three months, the longest period of immobilisation in this series, the ulna had united and the superior radio-ulnar joint was stable.

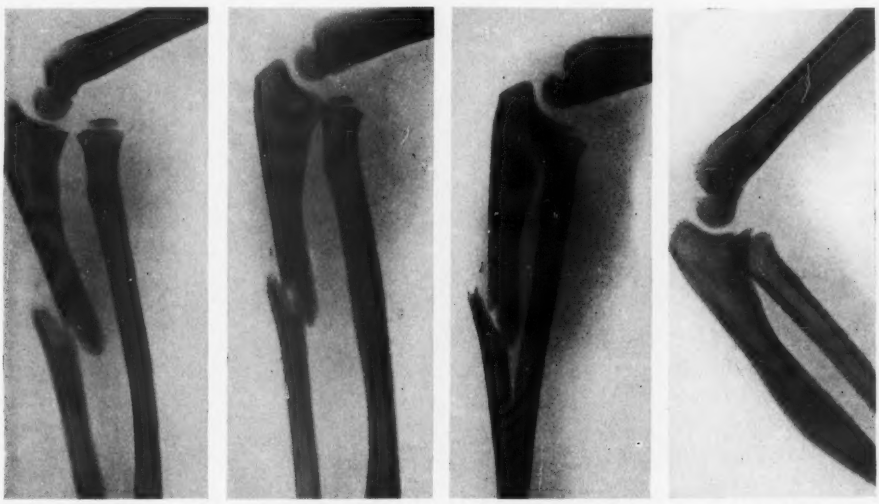


FIG. 24 FIG. 25 FIG. 26 FIG. 27

Case 6. J. G., aged seven years. Compound fracture of the ulna with anterior dislocation of the head of the radius. The upper fragment of the ulna penetrated the skin anteriorly, well away from the subcutaneous border. Figure 24 shows the position in fuli pronation and Figure 25 in mid-rotation. Figure 26 shows the reduction secured by full supination. Eight weeks later the fracture was united and the superior radio-ulnar joint was stable in all positions of rotation: Figure 27 shows that there was stability in full pronation.

FIG. 28

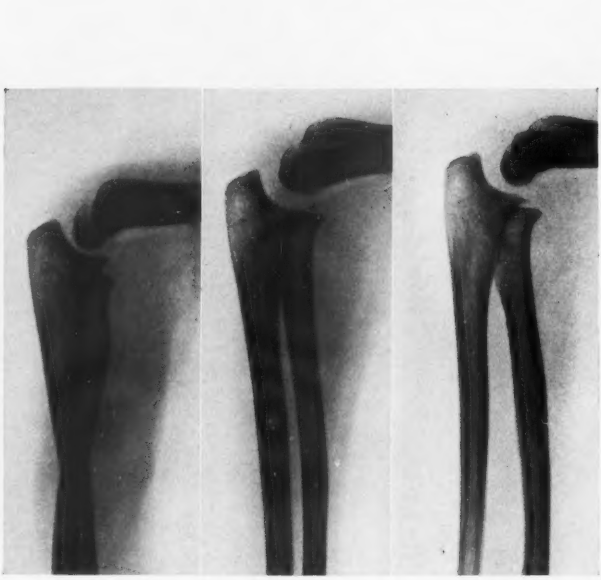


FIG. 29

Case 9. K. P., aged five years. A case of anterior dislocation of the head of the radius without fracture of the ulna (Fig. 28). Reduction was obtained by supination and immobilisation in plaster. Eight weeks later the reduction was stable in all positions of rotation (Fig. 29).

FIG. 30

FIG. 31

FIG. 32

Case 10. B. W., aged ten years. Severe pronation injury of the right elbow. Anterior dislocation of the upper end of the radius with separation of the capital epiphysis (Figs. 30 and 31). At operation, the superior radio-ulnar dislocation could be reduced only in full supination (Fig. 32).

ANALYSIS

Several points may be emphasized:

1) In nine of the eleven cases reduction of the superior radio-ulnar dislocation was achieved by closed methods and direct pressure on the radial head was required only twice. When closed manipulation was successful, full supination was usually necessary to reduce the dislocation, but in one exceptional case reduction appeared to be more complete in mid-rotation and the limb was accordingly immobilised in this position.

2) Two patients were submitted to operation. In one case the fracture was two weeks old and closed reduction failed; in the other there was wide separation of the epiphysis of the radial head and operation was performed for its replacement. In both cases it was observed by direct vision that the superior radio-ulnar dislocation was reduced by full supination and recurred when the forearm was pronated.

FIG. 33

FIG. 34

FIG. 35

Case 8. B. M., aged seventy-one years. An unusual case of fracture of the lower third of the radius with displacement and forward dislocation of the head (Fig. 33). The antero-posterior view of the tuberosity of the radius showed that the upper radial fragment was in neutral rotation (Fig. 34). Because the reduction of the head of the radius needed full supination the fracture was first plated. Three months later there was sound union and the superior radio-ulnar joint was stable (Fig. 35). Despite the patient's age, pronation was limited only 10 degrees and supination was full.

3) At the end of treatment radiographs in three rotational positions showed that in ten cases the superior radio-ulnar joint was stable and in perfect position. In the one case in which late open reduction had been performed (Case 4), there was slight forward subluxation of the joint in all positions of rotation.

4) The fracture of the ulna united in all cases and the maximum period of immobilisation in plaster was twelve weeks.

5) In ten out of eleven patients the final range of elbow movement was approximately normal. In the case in which the radial epiphysis was replaced at operation (Case 10), the final range of rotation was much restricted. This case is particularly interesting because of the history. The patient was a boy aged ten years who caught the sleeve of his coat in the rollers of a machine. His forearm was pronated with such force that he was picked up and whirled round twice before falling to the ground.

CONCLUSIONS

1. Anterior dislocation of the head of the radius with or without fracture of the ulna is a forced pronation injury.

2. Full supination is essential for reduction, and immobilisation in full supination is the surest safeguard against recurrence of the deformity.

I wish to thank Mr C. C. Jeffery for his help in the preparation of this paper; Professor C. F. V. Snout of the Department of Anatomy, University of Birmingham, for his co-operation in the experimental work; and Mr Gill of the Photographic Department of the Birmingham Accident Hospital for the preparation of the illustrations.

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RALPH CUMING AND THE INTERSCAPULO-THORACIC AMPUTATION IN 1808

J. J. KEEVIL, LONDON, ENGLAND

Surgeon Commander, R.N. (retd.)
Keeper of the Library, Royal College of Physicians, London

And some there be which have no memorial;
Who are perished, as though they had never been.—Ecclesiasticus.

In October 1882, Paul Berger, who was surgeon at the Hospital Tenon and Professor of Surgery at the Faculté de Médecine de Paris, amputated the whole upper limb of a patient with an enchondroma of the humerus. The next year he reported the result, and in 1887 published his classic work " L'Amputation du Membre Supérieur dans la Contiguité du Tronc." This was the first detailed monograph on forequarter amputation and, in the historical review, Ralph Cuming was named as the originator of the operation. Berger added that it had been performed only twice for war injuries, once by Cuming in 1808 and once by Gaetani Bey in Cairo more than thirty years later. Meanwhile, in 1836, it had been used for the first time in malignant disease by Dixie Crosby in New Hampshire.

In 1894, Cuming's priority was again recognised by W. W. Keen, Professor of the Principles of Surgery and of Clinical Surgery in the Jefferson Medical College. Keen published his results and gave a full description of his own technique as well as that of others including Berger. He reported another case in the following year. Both Berger and Keen were generous in recording the priority of Cuming despite the lack of any original record of his case, and the same scrupulous honesty has persisted to this day. Garrison gave him a place in the " History of Medicine," and Michael J. Smyth acknowledged his claim in the Medical Press (1946) and the British Medical Journal (1948). In all these references Cuming remained little more than a name, and even the date that was attached was not always the same.

Ralph Cuming was still a young man at the time of his death but there are many official reports of his work, many details of his life in the Service, and some account of the remarkable operation that he performed in the Naval Hospital at Antigua in 1808. As early as 1703 orders had been issued to Naval surgeons requiring them to keep journals and records of cases, and in 1731 there were further orders about these returns; but their value to posterity was not always recognised and many were destroyed, including all Cuming's journals. The difficulties are increased by defects in the Surgeons' Register which does not record his appointment as surgeon's mate and includes no reference to his degree of M.D., though this appears in the Monthly Muster Book of the Naval Hospital at Antigua, in February 1808, and also in his obituary notice.

A Naval pay register shows that Cuming joined the *Raison* on July 16, 1795, and remained as her surgeon until November 1797. This was a period of discontent, with demands for improved medical care of seamen, culminating in the mutinies at the Nore and Spithead. From the *Raison* he was transferred to the *Hind* in which he served till the summer of 1800. In neither ship did he see action or have much opportunity for surgery. At that time the only provision for nursing was a berth situated against the forecastle bulkhead on the upper gun deck, or in the fore-part of the hold which was damp, unwholesome and filled with stench from the bilges. At the close of the century Captain Markham of the *Centaur* designed the improved sick berth that came to be known by his name, but only four ships in the Channel Fleet had this accommodation at the time that St Vincent was appointed to the command. Cuming was then appointed to the *Redoubt* and after six weeks was moved to the *Leyden*.

Despite the constant actions of this period it was again his fate to be excluded from active combat and to miss the experience in emergency amputation that was gained by many naval surgeons.

In February 1801, having left the *Leyden* a few months before she was sent by Nelson to Boulogne where casualties were sustained in action, Cuming was appointed to the Naval Hospital at Yarmouth. Four months later, after perhaps gaining some surgical experience, he returned to sea, this time for a month in *Royal Oak* and then in the *St George* which had been Nelson's permanent flagship earlier in the year at the time of Copenhagen. His next ship, *Ramillies*, had also been at Copenhagen, but again he had no casualties to treat. The same fate attended him in *Malabar* of which he was surgeon for three months in 1805. He missed the action in which *Malabar* took part off Cuba in January 1806 and saw none throughout the year that he served in his last recorded ship *Pegasus*. It appears that throughout his life at sea the most serious injuries that he treated were those from accidental explosion of guns while reloading—a cause of many compound fractures and amputations.

These years must have seemed of little profit to Cuming, with his surgical bent, but there were many administrative reforms and changes in naval hygiene. The practice by which surgeons procured their own drugs was discontinued in 1796 and, in the next year, tea was substituted for the afternoon spirit ration. Preventive measures were introduced: cinchona bark in wine was given to all men employed on shore in the West Indies in 1797—a practice extended by Nelson to the Mediterranean station in 1803. The work of James Lind on scurvy had, at last, resulted in official prophylactic measures before he died at the age of eighty-three years (1799). The complacent acceptance of filthy conditions on the mess decks of ships, described so graphically by David Gillespie in his diaries, had given place to improved hygiene. In 1800, Lord St Vincent issued an order for the airing of hammocks and clothing, which, if one may judge from recent experience, must have been very unpopular. These were years of struggle for improved conditions of service, culminating while Cuming was in *Ramillies* with an Order in Council (January 22, 1805) establishing a uniform for surgeons and placing the medical service on an organised basis with relative ranks, though surgeons were only warrant officers. As yet, however, there was no official plan by which surgeons at sea could improve the slender knowledge with which they had passed their examinations on entry, and the fact that Cuming had few opportunities for emergency surgical experience makes his achievement all the more remarkable. He may well have felt that his professional lot was unhappy: "*But we, brought forth and rear'd in hours of change, alarm, surprise—What shelter to grow ripe is ours? What leisure to grow wise?*"

Soon after he left *Pegasus*, Cuming's destiny changed. In 1806, Matthews and Leigh of 18 Strand, London, published "Naval, Military and Private Practitioners' Amanuensis, Medicus et Chirurgicus . . ." The author, Ralph Cuming, M.D., R.N., was styled "Medical Superintendent to His Majesty's Naval Hospital, Antigua." No copy of his forgotten Amanuensis can now be traced; the name of Cuming was not to appear in print for another twenty-three years; but then it was to be made memorable.

In the London Medical Gazette, November 21, 1829, there was a long report by Mr J. Luke of the London Hospital of an operation performed successfully by him in October 1828 (pp. 235–239). He had removed three-quarters of the left scapula of a fourteen-year-old girl for sarcoma of the bone and it was said that she bore this formidable operation remarkably well "and did not faint." The account was read by a former naval surgeon, Mr A. Copland Hutchison* who practised in Duchess Street, Portland Place, London; and the next week he sent a letter to the Gazette. Through this chance correspondence we learn of Ralph

* Alexander Copland Hutchison, F.R.C.S., author of "Hutchison's Surgery" and other works on surgery served in the Navy from 1801 to 1807, and from his experience at sea, wrote books dealing with casualties in action and diseases among seafaring people. He became senior surgeon extraordinary to H.R.H. The Duke of Clarence and was senior surgeon to the Westminster General Dispensary.

Cuming's place in the history of surgery. In his letter Hutchison drew attention to a case he had seen in 1808 at Greenwich Hospital:

> "A young sailor, about twenty-one years of age, presented himself for a pension on account of the total removal by operation of the arm, scapula and clavicle, and I perfectly remember our sending the man to the College of Surgeons, or to some one of the London hospitals, to be there examined as to the successful result of this formidable operation. Gun-shot wound, I think, was the injury inflicted, and the operation was determined on and performed by Dr Ralph Cuming, then surgeon of the Naval Hospital at Antigua."

In a subsequent letter, published on January 23, 1830, in the Gazette, Hutchison added that the case had been examined at St Bartholomew's Hospital. He added that there was no doubt that the surgeon had removed the forequarter at operation and that it was not a case of traumatic amputation by the shot that wounded the seaman. Cuming's priority in performing interscapulo-thoracic amputation rests on this evidence. Hutchison gave no other details, and the few records of the Naval Hospital at Antigua that have been preserved shed no further light.

From later reports of amputation it is possible to form an idea of the hazards of the operation. It was in that year that new regulations had been issued for the Home Hospitals and if Cuming's patient had been at Haslar or Plymouth he would have benefited from the greater care then given to patients—bathing with soap and warm water, clean bed shirts, night caps twice a week, linen sheets fortnightly, hair mattresses, blankets and pillows. The surgeon was urged "to soothe and cheer their minds by the most humane attention, to hear with patience all their complaints, to explain and redress as far as possible whatever they may think grievances, by every expression of consolatory kindness, which will naturally inspire them with confidence, exhilarate their spirits, and add to their hope of recovery, to which it cannot fail to contribute." One nurse was to be allowed for every seven patients, with provision for night nurses. Hospital labourers cleaned instruments, prepared dressings, and attended patients when necessary.

Nevertheless few of the amenities provided in the new regulations for Home Hospitals can have been available in the Leeward Islands. "His Majesty's Naval Hospital at Antigua" was one of the many establishments that arose from the urgency of the times. The prevalence of yellow fever kept this small hospital full, and Cuming gained experience of this disease for he was responsible for the care of fever patients in addition to British wounded and wounded French prisoners-of-war. The buildings were placed on a low hill to the north-east of English Harbour, the dockyard on the south coast of the island which Nelson made one of his bases. These various establishments were gradually closed down at the end of hostilities, and by 1815 all naval staffs and stores had been centralised in Bermuda. But a map of Antigua, dated 1818, shows that the naval hospital was still in existence. The staff was indeed inadequate: it included only the surgeon, the second surgeon Robert Johnson, a clerk, matron, nurse, porter and barber, J. B. Douglas the dispenser, his negro assistant, and Pompee the watchman. By day, the entire nursing requirements were met by the matron and nurse: by night, "contractors' nurses" were hired to watch the sick. The whole establishment was administered by the hospital agent who was responsible for all expenditure; he himself drew the highest pay. Cuming's official pay was fifteen shillings a day, and three shillings and fivepence for rations; but he had so many allowances for other duties, such as attendance at the Yard, that in one quarter he was paid as much as £295, 12s. 9½d.

Cuming was handicapped not only by limited nursing help but by primitive conditions and a tropical climate. The risk of sepsis was obviously great. Boiling of instruments after contact with septic cases had been advised in 1808, and knives were scalded because it was believed that warm instruments inflicted less pain than cold steel. Opium or rum was sometimes used for analgesia but this was exceptional. A piece of leather for his patient to chew may well have been given by Cuming when he placed the young sailor on the chair.

With more consideration for the clothes of the patient than for his comfort it was usual to remove them entirely at this stage. The assistants grouped themselves about the chair.* John Woodall, in 1639, prescribed a minimum of five assistants. Sir Charles Bell,† writing thirteen years after Cuming's operation, reduced the number of assistants to four and in his "Illustrations of the Great Operations of Surgery" (1821) gave a vivid description of amputation at the shoulder joint. The legend to his illustration reads:

"1) The assistant, or friend who supports the patient in his arms. 2) A stout assistant, who holds a sheet which is round the patient's body, and who supports him against the pressure of the next figure. 3) The assistant surgeon, who stands behind the patient, and who, with his thumb, presses the sub-clavian artery above the clavicle. 4) A junior assistant should be seated here (on the floor), as much as possible out of the way of the operator. His business is to hold the shattered arm; to raise it, and move the humerus as the surgeon may direct, during the operation. 5) The operating surgeon, who now sees that everyone is in his place and knows his duty, and understands to do what belongs to him, without bustle and without improper interference."

Cuming had but one official assistant in hospital and moreover, for the technique of the operation he contemplated, he can have had no precedent. It is true that in student days he must have studied Alanson's work on amputations, of which a second edition had appeared a few years previously. He may have read Cheselden's description of Samuel Wood, the miller who in 1737 suffered traumatic right forequarter amputation while at work and was removed to St Thomas's Hospital the next day thus learning that gross mutilation was not incompatible with survival. He may have foreseen the chief danger of the operation—air embolism of the subclavian vein. We do not know whether he compressed the subclavian artery with a hard dry sponge above the clavicle, or whether he first resected the clavicle and ligated the vessels; both methods were used subsequently. His next step would have been the formation of an anterior flap and division of the pectoral muscles and brachial plexus, while the assistant made tense with his hands the structures to be divided. A posterior flap would then be fashioned with separation of the soft parts from the scapula and rapid tearing of the tissues, held by strong linen or leather retractors as the upper extremity was dragged away. Keen, in the age of anaesthesia, said that he took two hours to perform the operation in a case of malignant disease, but Cuming almost certainly subordinated everything to speed and used rapid sweeping incisions. Bell stressed the need for decision and rapidity, declaring that "the knife is to be handled more like a sabre than a surgeon's scalpel." Haemorrhage from so vast an area must have caused great anxiety; its control was entirely digital. Close on half a century was to pass before another naval surgeon, Thomas Spencer Wells, working in the hospital in Smyrna during the Crimean War, introduced the forceps

* The identity of the patient cannot be definitely established but the Monthly Muster Book of the Naval Hospital at Antigua has two entries which are perhaps relevant. Thomas Jones of the *Dominica*, Quartermaster, was admitted on March 11, 1808; he had an arm amputated and remained till April 22, 1808, when he was discharged to the *Pulturk* for passage to join the Fleet bound for Europe. John McInnes of the *Laura*, was admitted on March 18, 1808, wounded by a shot in the left shoulder; he was discharged June 16, 1808, to the *Lily* for passage to Europe. It will be noted that McInnes remained in hospital ninety days, Jones forty-two days, suggesting that the wound was more serious than the amputation. There is no mention of amputation in the case of McInnes but this does not exclude the possibility of traumatic amputation before admission. This view is supported by a statement by Samuel Cooper in his "Dictionary of Practical Surgery" (Second edition, 1813, p. 483): "I have lately seen, in London, a young sailor, whose arm was completely torn off at the shoulder, by a cannon-ball from one of the Forts at Guadaloupe, in March 1808; he suffered no dreadful concussion of his body, nor were his senses at all impaired. This case was very remarkable as the scapula was so shattered, that Mr Cummings of Antigua, was under the necessity of removing the whole of it. The patient recovered in two months. From the account I heard, I do not believe the axillary artery bled immediately after the accident. The young man was lately shewn to the gentlemen at St Bartholomew's Hospital, quite well." The testimony of Samuel Cooper suggests that John McInnes was the patient. However, Copland Hutchison, in his second letter to the London Medical Gazette, already mentioned, stated specifically that the amputation was not traumatic and his evidence was not further disputed. This suggests that Thomas Jones was the patient.

† Sir Charles Bell (1774–1842), graduate of Edinburgh, anatomical writer and artist, lecturer on anatomy and surgery in the School of Great Windmill Street, surgeon of the Middlesex Hospital, Professor of Surgery, Edinburgh.

named after him. Cuming had to grasp the great vessels between finger and thumb while his assistant placed a ligature about them. Silk had displaced wax thread for this purpose, in accordance with the practice of French surgeons. When the wound was finally closed, and the edges were held in accurate contact with adhesive straps, it was probably dressed with a poultice, a method that remained in favour until it was displaced by the absorbent dry dressings introduced by Gamgee in 1855. Over the poultice were placed broad and long straps of adhesive plaster reaching across the back and breast. Finally a spica bandage was applied. Such cases were usually dressed on the fifth or sixth day when " emollient cataplasms " were applied to correct the tension and inflammation. Cuming would give his patient the customary thirty drops of laudanum, repeated twenty minutes later if there was no relief from pain. It was usual to give wine every two or three hours. " Symptomatic fever " was treated by purgation and barley water acidulated with *crem. tartar*. The healing of such a wound must have taken at least three months under the septic conditions in which Cuming worked. The whole record may horrify the surgeon of to-day, and yet we must respect the confidence and courage with which Cuming extended the frontiers of surgery under such immense difficulties. There is no doubt that he deserves a place in history with those of his great contemporaries.

In all these Leeward Islands there are enclosures, seldom frequented, to which the curious stranger may be drawn by shaded solitude or the glimpse of an obelisk or pillared urn. The dappled sunlight plays on inscriptions that record a great tragedy, for these are the graveyards of yellow fever. It is not that special cemeteries were reserved for its victims but that sometimes this was the only cause of death. The infection that decimated colonists, and swept away garrisons, cut down the young and vigorous. Throughout the spring and early summer of 1808 the number of " fever " admissions to the Naval Hospital at Antigua increased steadily and in the first six months of 1808 they accounted for nearly all the 650 admissions. The mortality was high and many patients were noted in the muster book as being in a dying state. Epidemics were capricious; they appeared sometimes in the urban population and at other times among the plantation workers; Europeans, newly arrived in the island, might escape while the seasoned garrison succumbed; whereas at other times the new arrivals died in great numbers. As late as 1866, when Thomas Nicholson published his " Essay on Yellow Fever," based on long experience in Antigua, it had proved impossible to arrive at any conclusion that would indicate the probable course of an epidemic, still less its cause. Blood-letting and massive doses of calomel and quinine proved uncertain remedies, and the authorities agreed that, since nothing could be done, the chief duty of medical officers was to cheer the victims and maintain their spirits. Cuming was a surgeon but he attended to the fever cases. He attempted a new method of treatment—the application of cooling dressings soaked in rum. In that climate they must at least have brought some relief and the results appeared to jurtify reports to the Admiralty. Cuming wrote asking for bottles and utensils; he wanted a further assistant—a " Hospital Mate "; he wanted a General Inspector of the hospital; he asked that his work as physician should be recognised since the Board had stopped all private practice. The many letters he sent to the Admiralty disclosed the strain under which he was working. On February 8 he wrote on a more serious matter, sending an affidavit respecting an affray between himself and Captain Napier of the *Pulturk*. The Board accepted his explanation and added, in their reply of April 7, that the iron cradles he needed were being sent; they asked to be informed further of his experiments on " Refrigeration with Rum." But in Antigua itself Cuming's relations were less satisfactory. It may be that his many activities, and the emoluments arising from them, were a cause of jealousy; it may be that he was trying to do too much, that he was too direct in his methods, and that he was lacking in sensibility. On February 9, 1808, he wrote to the Admiralty saying that the incidence and mortality of the fever could be reduced if certain local measures were taken. He referred to the ease with which sailors could procure rum, to the debilitating

effects of exposure to the sun and excessively heavy work, to the laxity with which men were allowed to sleep exposed to the night air, to the excessive shore leave and inadequate nutrition, and to the need for substitution of bread for biscuits. The soundness of his principles was established by the regulations that were framed later, but at the time they were probably no more than a source of irritation to the island authorities. The whole unhappy position is revealed in a letter from the Commander-in-Chief, the Hon. Sir Alexander Cochrane, Rear-Admiral of the White, dated February 4, 1808. He informed the Commissioners of the Admiralty that the surgeon at the Naval Hospital at Antigua had been involved in disputes and quarrels ever since his arrival in the island, that his complaints were so frequent and voluminous that the Commander-in-Chief could not attend to them all, that he was "litigious," that he was heartless, that while still in their hearing he declared that patients would die, and that he performed his professional duties in an ungracious manner. Cochrane asked that Cuming should be superseded. There could be only one answer to such a letter, and a pencil note was scribbled on it by the Board to the effect that immediate action was to be taken. Another marginal note on the letter states that Cuming was then dead.

The incidence of yellow fever in the region of the Naval Hospital and chief military station in Antigua was high. Thomas Nicholson, writing of the epidemic of 1849, remarked on how "indeed, the poisonous atmosphere appeared to be confined within very small limits," and it was within these limits that Cuming lived and that tragedy overtook him. On June 24, 1808, young Ralph Cuming, his son, died; and the next day he himself died. The notice that appeared in the Gentleman's Magazine for September 1808 is very brief and does not mention the infection that killed father and son. There is no relevant entry in the hospital muster book except that R. Johnson was appointed Surgeon on June 25. It is likely, however, that they died of the all-prevailing fever. The obituary pays tribute . . . "his loss will be severely felt . . . a very skilful and able surgeon" and there, far from his home in Romsey, Hampshire, the story of Cuming's brief triumph ends. It was only twelve years since he had been passed by the Company of Surgeons as second mate of a first rate "At a Court of Examiners holden at the Theatre the seventeenth day of April, 1794." He had more than justified the high estimate of his examiners.

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PIONEERS OF OSTEOGENY

FREDERICK OLDFIELD WARD

JESSIE DOBSON, LONDON, ENGLAND

Recorder, Royal College of Surgeons of England

Frederick Oldfield Ward entered the Medical School of King's College Hospital in October 1833, when he was fifteen years of age. His parents resided at that time in Camberwell and his early education had been gained with a Dr Knox of Tonbridge. His career as a student appears to have been successful enough and we know that he gained a medal in Chemistry in 1835 and a silver medal in Botany in 1837. While still a student he wrote "Human Osteology" which was published in 1838. In the preface he said that his book was the result "partly of researches in the museum and dissecting room, prosecuted at intervals during the last five years: partly of a careful perusal and comparison of the best English and foreign works on the subject," and added that his aim in the work was brevity. "But holding that true brevity consists not in expressing ideas in a small space but in conveying them in a short time, I have not thought it inconsistent with this design to dilate freely upon some obscure and difficult points which have been passed over in a few lines by previous writers... Whatever contradictory statements came under my notice in the course of this comparison were noted down, and made the subject of careful research in several extensive anatomical collections . . . which afforded me the opportunity of comparing nearly two hundred specimens of each bone."

The book is of small dimensions. The pages of the first edition measure only two and three-quarters by four and a half inches, the volume being one and three-quarters inches thick. Though it cannot be said to present the attractions of the modern text-book, its text and illustration achieve a degree of accuracy and a level of descriptive writing that is seldom encountered even to-day.

No record can be found of his taking the final qualifying medical examination but we know that for some years he practised as a surgeon. His interests extended far beyond the confines of medicine. In 1842 he published an essay on mosaic and tessellated pavements. He became acquainted with Mowbray Morris, manager of the *Times*, and it was evidently arranged that Ward should write a series of articles for the newspaper on subjects of general interest. Several of these dealt with the water supply of large towns, and in a letter to Mowbray Morris, dated October 16, 1849, he says: "I hope you will not think me proud or wrong for mentioning this further fact—but I was assured (and I think not for flattery's sake but *bona fide*) that our sanitary articles have attracted special notice and are producing an extension of the sanitary power, etc. The vast subject of this arterial organisation of the metropolis is shaping itself in my mind. I seem to see the intricate subterranean tubes—the heart-like engines—the inward flowing water—the outward *caput mortuum*—mapping itself underground and beginning to palpitate and live—as when incipient vitality first stirs the sleeping germ within the egg." An article on the fungoid theory of cholera appeared in November 1849, and there were others relating to matters of public health.

The fee agreed was five guineas per column, but letters written by Ward to Mowbray Morris in 1850 reveal that the monetary arrangements were far from satisfactory to him. He stressed the great value of his contributions and their effect upon the public. In July of that year he submitted a plan for the organisation of the newspaper. "While recommended by an extreme simplicity and facility of execution, it appears like to produce a profit of from £500 to £1000 a year if adopted. I am accustomed to think it fair and legitimate that a man

who is not rich should profit by his devices, whether literary or industrial, and should you see no objection to the proposal I would agree to communicate this plan to the *Times*, leaving the Journal the option of adopting or rejecting it, on condition that, in the latter case the plan should not be divulged, and in the former that the resulting benefit should be equally divided between the proprietors of the *Times* and myself." Letters exchanged at this time between the Manager and Ward show that relations between them were becoming increasingly difficult and, indeed, their friendship would have ceased altogether had it not been for the intervention of Professor Partridge, of King's College. Ward's connection with the newspaper, however, terminated at the end of July 1850.

He took service as a clerk to Joseph Hume who introduced him to Edwin Chadwick, both of whom were pioneers of the new medico-legal group of sanitary reformers. Fired with their enthusiasm, Ward wrote at this time a number of popular articles in which he criticised water supply and hygiene and proposed control under one central board of all sanitation in Great Britain. Many papers were published at his own expense. On September 20, 1852, he attended a Congress of Hygiene at Brussels and delivered an address entitled "*Circulation ou stagnation?*" A contemporary writes speaks of him as: "An able writer, a persevering speaker or rather reciter of his own pamphlets, with a special talent for claptrap phrases and the faculty of rapidly acquiring and employing, when addressing an uneducated audience, the technicalities or hard words of any science. He began to study hydraulics (the most abstruse branch of engineering) when he became a drainage agitator and he knows just enough of the higher branches of arithmetic and mathematics to astonish and puzzle those who know nothing: but he has two qualifications which serve him well—courage and connections."

At this time he also speculated in many small patents and it is said that unsuspecting tradesmen paid dearly for their infringement of forgotten patent rights of his inventions. In 1854, on the recommendation of Lord Palmerston, Ward was appointed Commissioner of Sewers and evolved a plan for the drainage of London. The theory was acknowledged to be excellent but was said to be impossible of execution: it was described as the "quart-into-pint-pot" plan. Political unrest at this period, combined, maybe, with his advanced and eccentric ideas, caused him to lose his office, though he apparently continued his investigations into the subject of water supply, for in September 1856 he addressed the International Congress of Public Health in Brussels and in the same year prepared the second edition of "Human Osteology." Two years later, a letter from Ward on purification of the Thames was published by William Coningham, Esq., M.P., to whom it had been addressed. Apart from this, nothing is known of his activities for almost twenty years though Sir John Simons, Medical Officer of Health for London, who had been a fellow-student at King's College, mentions in his "Personal Recollections" that before his death Ward suffered "enfeeblement." In 1875 Ward completed the third edition of "Human Osteology." His mental and physical powers deteriorated to such an extent that he entered St George's Retreat Lunatic Asylum at Ditchling, near Lewes, and died of general paralysis of the insane on November 15, 1877.

Ward's experiments to show the nature and composition of bone provide interesting conclusions. He studied the elasticity of the clavicle and wrote ("Human Osteology," page 284): "The clavicle has always been supposed to possess a certain elasticity in virtue of its double curvature; but no attempt, I believe, has hitherto been made to ascertain, by direct experiment, the amount of its resilient property. I have endeavoured, by the following experiments, to obtain an approximate measurement of the elastic force resident in this bone. A clavicle was taken from a well-developed, middle-aged, male subject, shortly after death, and laid upon a smooth surface, with its shaft perpendicular to the plane of a wall, against which its inner extremity rested. Upon the outer extremity of the bone, thus disposed, a smart blow was now struck with a hammer, in the direction of its long axis. The hammer rebounded from the end of the bone, which sprang to a distance of nearly two feet from the wall. Mr Fergus of King's College, in whose presence the trial was made, suggested that the

effect might depend in some measure on the elasticity of the cartilage with which the ends of the bone were invested. The experiment was repeated after the cartilage had been removed by scraping and thereafter the bone sprang as far, and sometimes even farther, than before. Another experiment conducted on tissue from the centre of the lateral condyle of the femur was designed to show the strength of the reticular tissue, a cubic inch of which could sustain 'four hundredweight without sensible alteration.'"

which *a* is the principal support, and *b* a cross piece tying *a* to the wall or column which sustains the whole. It is evident that the piece *a* contributes by its *rigidity*, and the piece *b* by its *tenacity*, to the support of the weight;

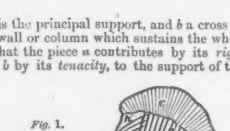

Fig. 1.

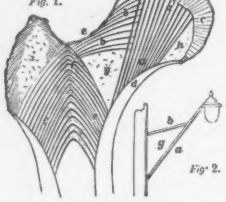

Fig. 2.

in other words, that the weight tends to *bend* the former, and to *stretch* the latter. Referring to Fig. 1 (in which the direction of the principal fibres is shown with fictitious

FIGS. 1 and 2
Reproduced from page 370 of "Human Osteology" by Oldfield Ward.

On page 370 of "Human Osteology," Ward illustrated the triangle in the neck of the femur with which his name is still associated (Fig. 1). He wrote: "The structure of the neck is shown at Fig. 1 in the subjoined diagram. It resembles in its mechanical principles a bracket of the kind represented in Fig. 2 in which *a* is the principal support, and *b* a cross-piece tying *a* to the wall or column which sustains the whole. It is evident that the piece *a* contributed by its rigidity, and the piece *b* by its tenacity, to the support of the weight; in other words, that the weight tends to bend the former, and to stretch the latter. Referring to Figure 1 (in which the direction of the principal fibres is shown with fictitious distinctness—the cross filaments, etc., being purposely omitted) we find the pieces *a* and *b* of the bracket respectively represented by the sets of bony fibres marked *aa* and *bb*. The fibres *aa* are inclined columns supporting the epiphysis of the head *cc* and resting below upon the thick wall *d* of the neck. The transverse fibres *bb* decussate the columns *aa*, and tie them to the thin upper wall *e* of the neck, and to the arch-work *ff* of the upper extremity. The middle of this arch-work presents a column of more condensed tissue, indicated by the shaded portion *f* in the diagram: this results partly from the decussation of the convergent fibres, partly from the presence of several bony canals for the reception of nutrient vessels, that here descend vertically into the bone through orifices in the upper wall of the neck. The interval *g* (which obviously corresponds to the interval *g* between the parts *a* and *b* of the bracket, Fig. 2) is filled with a loose reticular tissue, presenting no determinate nor uniform arrangement."

A similar area is to be found in the calcaneum and Ward's description is as follows:

"Thus, for example, a vertical section of the calcaneum from end-to-end exhibits the principal fibres radiating from the astragalar articulating surface—some horizontally backwards to receive the transverse strain of the great extensors of the foot—a considerable number obliquely downward and backward, to transmit, through the tubercles of the heel to the ground, the pressure received from the astragalus—while a third set run forward, diverging from each other as they advance, to strengthen the greater process. As, however, this bone is subject to no directly vertical pressure, nor to any strain which directly vertical fibres would help to resist, so we find no such fibres in the cancellous structure, but in their place (between the fibres that descend obliquely backward and those which descend obliquely forward) an empty triangular interval. The same economical distribution o

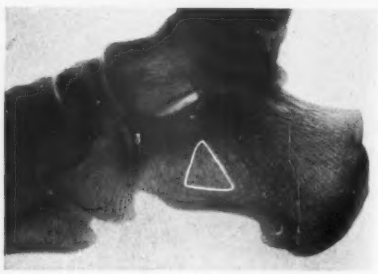

FIG. 3
Ward's triangle in the calcaneum.

materials is observed in all the tarsal bones; and it accounts for the great resisting power which they possess in proportion to their weight."

Ward was particularly interested in the special structure of bone whereby its strength was increased. He made this observation: "The arrangement of the cancellous tissue in the ends of the femur is very remarkable; and, as it illustrates the general mechanical principles which determine the structure of this tissue throughout the skeleton, it should engage our particular attention. In the lower extremity of the bone, it consists of numerous slender columns, which spring on all sides from the interior surface of the compact cylinder, and descend, converging towards each other, so as to form a series of inverted arches, adapted by their pointed form to sustain concussion or pressure transmitted from below. These converging columns not only meet but decussate each other; and they are further strengthened by innumerable connecting filaments and laminae, which cross them in all directions, so that no single arch could break without those in its neighbourhood also giving way. Hence, notwithstanding the tenuity and brittleness of each several fibre, the reticular structure possesses great strength as a whole."

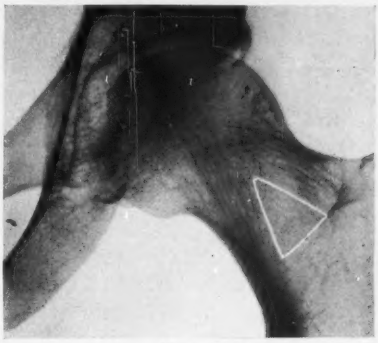

FIG. 4
Ward's triangle in the neck of the femur.

Ward's account of the triangle in the neck of the femur attracted little attention for many years, but the introduction of roentgen rays showed clearly that the translucent triangular area was a normal feature of the femoral neck (Fig. 4). Mention of it appeared in text-books. It is unfortunate that in "Text-book of X-ray Diagnosis," edited by Shanks, Kerley and Twining, Ward's triangle is defined wrongly (Volume III, page 289). Ward's triangle in the calcaneum is shown in Figure 3.

I would like to express my gratitude to Mr Maywood, Librarian of the *Times*, for permission to read and reproduce extracts from Ward's letters.

FROM AN ATLAS OF GENERAL AFFECTIONS OF THE SKELETON

11. ACHONDROPLASIA

Synonyms—Chondrodystrophia foetalis, Micromelia

H. A. THOMAS FAIRBANK, LONDON, ENGLAND

Achondroplasia is a congenital condition resulting from interference with enchondral ossification and is characterised by dwarfism of the short limb type, associated with a large head and, in many cases, so-called "trident hands." It is the commonest type of dwarfism and perhaps the most ancient: there is clear evidence of its existence several thousand years ago. Although he was not the first to recognise that this affection was distinct from rickets, it was Parrot (1878) who suggested the descriptive title, achondroplasia. The term chondrodystrophia foetalis was suggested by Kaufmann in 1892. Even in recent years many cases have been reported as examples of achondroplasia which really belong to the chondro-osteo-dystrophy group, while numerous "atypical" cases have been published which at present it is impossible to classify.

As to its frequency, Caffey (1948) reported that at the Babies' Hospital in New York City forty-three achondroplasiacs were identified radiologically in the course of fifteen years; in the same period there were fifteen cases of osteogenesis imperfecta, fourteen ateleiotic dwarfs, ten cases of gargoylism and nine of multiple exostoses (diaphysial aclasis). Achondroplasia undoubtedly occurs in certain animals, but it is no longer regarded as a satisfactory explanation for the stunting of limb-growth in all short-limbed species. A lethal form of the disease has been reported in rabbits (Brown and Pearce 1945).

Hereditary and familial influences—These are apparent only in a minority of cases; but achondroplasia has been traced through as many as six generations in the male line (Phemister 1924). Most cases—nearly 90 per cent. of the series studied by Mörch (1941)—are sporadic. Nevertheless there is a 50 per cent. chance that a child, one of whose parents is an achondroplastic dwarf, will also be affected. Difficulties in labour in the female achondroplasiac interfere with inheritance. It has been met with in twins, one or both being affected.

Sex—Females are rather more frequently affected than males. Rischbieth and Barrington (1912) found seventy females and fifty-six males in the series they investigated.

Age—The characteristics are present at birth, whereas in cretinism and chondro-osteo-dystrophy the special features, including the dwarfism, develop after birth. It is usually said that most die before, at or soon after birth, which is often premature at about the eighth month. The maternity hospital records examined by Mörch showed that 80 per cent. of affected children died during the first year of life. In view of these statements it is curious that the patients that survive are so singularly sturdy and robust, and that they live to an advanced age.

Etiology—Achondroplasia results from a developmental fault inherent in the ovum, the cause of which is entirely unknown. Of the various explanations that have been suggested none has received general acceptance. The failure of normal ossification of the long bones is apparent in the foetus towards the end of the second month, or early in the third month, of foetal life. This fact, and the occurrence of the condition in only one of a pair of twins, eliminates the possibility of an endocrine error as the cause. It affects all races and, as already mentioned, it occurred in prehistoric times. This is one of the conditions which Jansen (1912) suggested were the result of excessive intra-uterine pressure caused either by hydramnios or a small amnion; but if this is true, how is it that most cases are so singularly true to type?

Clinical features—These are obvious at birth, whether the child is alive or dead. Dwarfism is the most striking feature, the reduction in height being due chiefly to shortness of the lower limbs. When adult life is reached and growth ceases the height is usually less than four feet and may be as little as two feet six inches. The mid-point of stature is always abov

the umbilicus and may be as high as the lower end of the sternum. Although the spine is affected to some extent, the limbs are strikingly short in comparison with the trunk. The fingers may not reach below the greater trochanters. The shortness of the lower limbs may enable a child to kiss his toes with ease when standing. The proximal segments of the limbs —the humeri and femora—are more affected than the distal segments (rhizomelic micromelia). The head is large and brachycephalic, and suggestive of hydrocephalus which may be present in mild degree, though it is not progressive (Dandy 1921). The frontal region is rather prominent and the bridge of the nose is depressed and flattened. The lips are often thick and during the early months of life the tongue may protrude. The mandible may be somewhat prognathous. Dentition is normal. The spine may be lordotic but is often surprisingly flat, the apparent lordosis being due more to the unusual prominence of the buttocks than to excessive curvature of the lumbar spine. This deformity does not flatten out as the child is laid on its back, not even when the hips are fully flexed. There may be a kyphotic curve in the dorsal region. The chest is small and flat, the ribs being abnormally short with perhaps some "beading" at their anterior extremities (Parsons 1936): the costal cartilages are unaffected. The breadth of the shoulders is up to the average. Movements of the shoulder joints and supination of the forearms may be somewhat limited (Caffey 1948). Fixed abduction of the upper limbs, with limitation of adduction, has been reported. Extension of the elbows may be limited: in one case examined, extension was checked at 120 degrees.

The hands are short and broad, and frequently, but not invariably, they display a typical deformity. The middle finger is short and the fingers are more nearly of equal length than in a normal hand. The digits, which are all rather short and thick, diverge, the space between the second and third fingers being particularly wide: thus is formed the "main en trident" of Marie (1900). The legs are often bowed, except in younger children in whom they are usually straight and only occasionally valgoid. The bowing, associated in some cases with hyperextension of the knees, is due mainly to curvature of the tibiae, the deformity occurring usually, but not invariably, in the upper part of these bones. Correction of deformity by osteotomy may be justifiable, but is seldom necessary. The head of the fibula lies abnormally high. The general appearance of the limbs is one of sturdiness with some enlargement of the ends of the bones. The musculature is often above the average: these patients may perform feats of strength and be able to rise from the floor in one movement (Parsons 1936). The gait is rolling—probably because of the backward tilt of the pelvis and the posterior displacement of the hip joints; it is certainly not due to coxa vara, though it is often stated, quite incorrectly, that this deformity is always present.

The skin is thick and the soft tissues generally seem to be too long for the limbs so that, in younger children, folds and furrows are formed between rolls of fat. The abdomen is rather large and prominent. Intelligence is normal; but the subjects of achondroplasia may be affected psychologically by their difference from other children or by the curiosity they invoke if they join a performing troupe. Sexual development is normal, or it may be somewhat excessive.

Although in most cases the whole skeleton is affected, the impairment of growth is occasionally of a more limited distribution; exceptionally the dwarfism is even confined to one limb. The author has seen a woman with both humeri dwarfed to a marked degree while the forearms, lower limbs, head and body were all of normal size.

Blood examination reveals nothing abnormal.

Radiographic appearances—The long bones are short, strong and rather dense. The femora and humeri may be less than two-thirds of the normal length. The curves and muscular impressions are exaggerated. The shafts may be thickened but usually the increase in diameter is more apparent than real and is due to the reduction in length. The medullary canal is reduced in size and may be obliterated by cancellous bone. Splaying of the ends of the shafts is more abrupt and obvious than in normal bones and the terminal surface is irregular. In some of the major long bones, notably in the region of the knee joint, the end

of the shaft is notched centrally to form a V-shaped surface. The epiphyses appear to be large but as a rule they are not abnormal in size. They may begin to ossify somewhat early; while fusion with the shafts shows great variation, occurring either early, late or at the normal time. A striking feature is the position of the epiphysial centre close to the end of the shaft, and tucked into the apex of the V-shaped notch of the metaphysis when this is present. The two limbs of the notch may appear to embrace the epiphysis—an impression that is confirmed by histological examination. In young children the position of the epiphysial centre so close to the diaphysis results in considerable increase in depth of the joint space as seen in radiographs (Fairbank 1934). In a stillborn infant there may be such shortness of the diaphyses that more than half the length of the limb is formed by the epiphyses (Khoo 1945). The clavicles and fibulae are much less affected than other long bones. The relative excess in length of the fibula may be regarded as a persistence of the condition that is said to be present normally at the eighth month of foetal life. The fibular head lies higher than usual: occasionally it may even participate in the formation of the knee joint. Sometimes the shaft of the fibula is bowed. The ulna, on the other hand, is occasionally shorter than the radius, as it may be in several other general affections of the skeleton. The ribs are short—sometimes even less than half the normal length. The sternum is short, broad and thick, and the sternal angle is increased. The scapula is deformed, its shape suggesting that the inferior angle has been cut off; and the glenoid is too small for the humeral head. The pelvis is reduced in size in all diameters. The ilium, especially in adults, is small and the crest is thickened. In children the lower part of the ilium, above the acetabulum, is broader than normal and the bone as a whole is of a curious shape. The hip joint lies farther back than usual, so that the acetabulum abuts on the sacro-sciatic notch. Sometimes the pubic arch is unusually wide. The sacrum is narrow and tilted to an abnormal degree, its promontory protruding more than usual into the pelvic cavity. Coxa vara is often stated to be common, even "invariably" present, but this is not supported by examination of radiographs.

The skull is large: the sella may be small. The characteristic feature is premature fusion of the pre-sphenoid, post-sphenoid and basi-occipital, to form an os tri-basilare which is abnormally short. As a result there is considerable diminution in length of the base of the skull. The foramen magnum is small and funnel-shaped; its diameter may be reduced to half the normal. The facial bones are unaffected. The vertebral bodies may be somewhat reduced in depth but the total reduction in length of the spine is much less marked than that of the limbs. Reduction in size of the ossific centres for the vertebral bodies was regarded as a constant feature by Parrot (1878); but the bodies are never noticeably shallow and the kyphotic curve is long and gradual. Nevertheless angular kyphosis, suggestive of that met with in the two types of chondro-osteo-dystrophy, was seen in two undoubted cases of achondroplasia examined by the author: in one patient only two years old the deformity almost disappeared on standing.

Progress—Even when fusion of the epiphyses is delayed, adults are always far below the normal in height.

Pathology—There is relative aplasia of cartilage at the ends of the long bones. Growth of all cartilage cells of the epiphyses is disorderly. According to Harris (1933), mucoid degeneration of the cartilage is "the underlying feature." It may be degenerate, fibrillar, vacuolated and unusually vascular. There is absence of the normal columnar palisade arrangement at the epiphysial line, and provisional calcification is erratic. The spongiosa is irregular and tends to be dense, with the cartilage cores diminished in calibre or entirely absent (Caffey 1948). Harris regards the shafts as the serial summation of lines of arrested growth. Periosteal ossification is normal or excessive. The periosteal ferrule "outstrips and overlaps the cartilage-formed bone" (Keith 1919). This explains the radiographic appearances in which it was noted that the cortex of the metaphysis appears to embrace the adjacent part of the epiphysis. An important feature, often but not invariably present, is the ingrowth

from the periosteum of a vascular fibrous band or layer between the zone of ossifying cartilage at the epiphysial line and the rest of the epiphysis; if, as occasionally happens, this fibrous layer extends across the whole diameter of the bone, further growth of the shaft must necessarily cease. According to Knaggs (1927) this band may be formed by metaplasia of the cartilage. The thymus, thyroid and pituitary show no constant changes.

Death at or shortly after birth is attributed either to the inadequate capacity of the thorax or to excessive reduction in the size of the foramen magnum. It has been said that general oedema and ascites may cause difficulty at birth.

Diagnosis—Achondroplasiacs display their typical features at birth, whereas infants with either of the two types of chondro-osteo-dystrophy usually pass as normal for the first one to four years of post-natal life, and owe their dwarfism to the spine rather than to the limbs; moreover in these dwarfs kyphosis, rather than apparent lordosis, is the rule. In the Morquio-Brailsford type of chondro-osteo-dystrophy the head and face are normal; while gargoylism is distinguished by the heavy facies, mental deficiency, corneal opacities, and enlargement of the liver and spleen. In cretinism the characteristic features are not recognisable at birth. The only condition that is likely to simulate achondroplasia at birth is osteogenesis imperfecta: in a severe pre-natal case of this condition, the subject, whether alive or dead at birth, may display marked shortening of the limbs as compared with the trunk; but radiographic examination at once settles any doubts as to the diagnosis. Short limbs at birth may also be seen in dysplasia epiphysialis punctata, but this is an exceedingly rare condition with unique radiographic features.

FIG. 52

Case 17. Typical achondroplasia in a female infant. Note that the dwarfism is due chiefly to shortness of the lower limbs —not the trunk. The mid-point of stature is at the lower end of the sternum. The fingers reach only to the greater trochanters. The soft tissues of the limbs are too long for the bones so that there are many cutaneous creases and rolls of fat.

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CASE 18—ACHONDROPLASIA

(Figs. 53–57.) Male, aged seven years. Typical case. Some limitation of extension of the hip. Extension of the elbow joints limited. Subluxation of the head of the radius, particularly in the left elbow: the subluxation occurs on flexion, the radial head resuming an approximately normal position on extension. Outer ends of clavicles bent down. (Under Dr R. S. Frew)

FIGS. 53 and 54

FIG. 53

Case 18. Typical short-limbed dwarf (Fig. 53) with large head, prominent forehead, depressed bridge of nose, small flat chest and prominent abdomen, long dorsi-lumbar kyphosis with minimal true lordosis but with prominent buttocks, and relative shortness of all four limbs, particularly the proximal segments (rhizomelic micromelia). Figure 54 shows the unusual shape of the ilia, and the absence of coxa vara though the femoral necks are prolonged inwards at the epiphysial lines. Note the short femoral shafts, splayed at the extremities, particularly the lower which show the typical central notches into which the epiphyses fit.

FIG. 54

FIG. 55

Case 18. Hands showing typical trident deformity and thick digits.

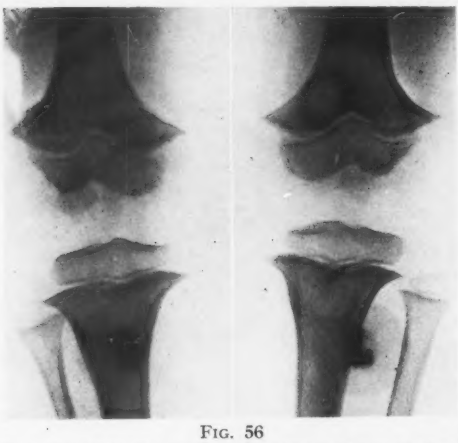

FIG. 56

FIG. 57

Case 18. Note the marked splaying of the metaphyses of the femora and tibiae (Fig. 56), the central notches particularly in the femora, the close proximity of the epiphyses to their respective shafts, and the wide joint space in both knees. The upper limb (Fig. 57) shows the stout shaft of the humerus with an unusual shape of the extremities of the bone. The radial head is in an approximately normal position, the elbow being extended to the limit.

CASE 19—ACHONDROPLASIA

(Fig. 58.) Female child, aged seven months, who displayed all the features of achondroplasia. There was some asymmetry: both upper limbs were relatively short, as also were the lower limbs, but the left upper limb was shorter than the right. The head was large. There were trident hands with pointed fingers. There was a low dorsal kyphosis. (Under Dr R. S. Frew.)

FIG. 58

Case 19. Radiograph of the leg shows the position of the epiphysial centres in the region of the knee joint, close to the ends of the shafts and not in the middle of the cartilaginous epiphyses. Note the apparent widening of joint spaces.

CASE 20—ACHONDROPLASIA

(Figs. 59 and 60.) Female, aged five years. Typical case.

FIG. 59

Case 20. Lower limbs showing the typical short stout bones with splaying at the extremities, irregularity of the ends of the metaphyses, and characteristic position of the ossific centres. Note the length of the fibula: the head is abnormally high in both legs; at the ankle joint the fibula reaches rather lower than usual.

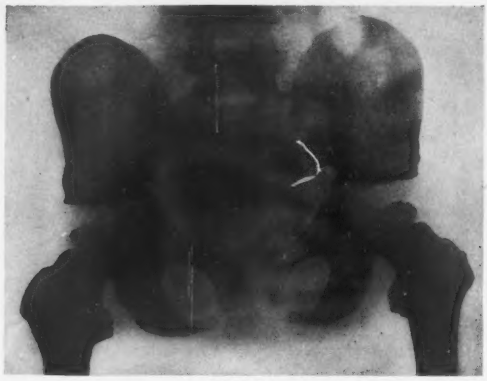

FIG. 60

Case 20. Pelvis and hips showing the same curious shape of the ilia as seen in Figure 54. Note the flat horizontal roof of the acetabulum on both sides The femoral necks show some lipping on the inner side but are not varoid.

CASE 21—ACHONDROPLASIA

(Figs. 61 and 62.) Female, aged five and a half years. Typical case, clinically and radiographically, except that the spine displays deformity that is suggestive of the chondro-osteo-dystrophies. (Under the late Sir Henry Gauvain.)

FIG. 61

FIG. 62

Case 21. Photograph shows the typical features of achondroplasia (Fig. 61). The lateral view of the spine shows the twelfth dorsal body, slightly wedge-shaped, forming the apex of an angular kyphosis. Note that the shape of the vertebral bodies differs both from that seen in the Morquio-Brailsford syndrome and from that typical of gargoylism.

CASE 22—ACHONDROPLASIA

(Figs. 63–65.) Female, aged two years. Below normal height for her age. Relative shortness of the limbs, especially the proximal segments. Head large: facies not typical. Intelligence normal. Hands trident. Slight limitation of extension of the elbow joints. Angular kyphosis of the spine with apex at dorsi-lumbar junction: on standing the kyphosis almost disappears. Radiographic appearance of long bones and of ilia is typical of achondroplasia. The lower ends of the scapulae are square, as if the angles had been cut off.

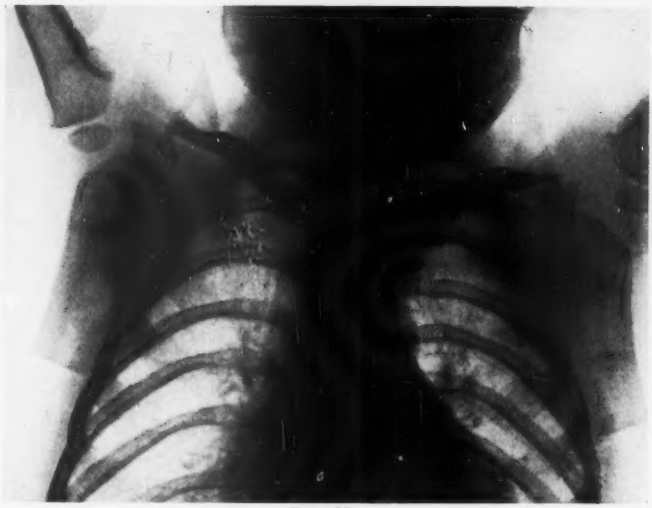

FIG. 63

Case 22. Thorax and shoulders with arms elevated to show the curious square " angles " of the scapulae.

FIG. 64

FIG. 65

Case 22. Pelvis and lower limbs showing the typical shape of the ilia, femora and tibiae (Fig. 64). Lateral view of the spine shows angular kyphosis at the first-second lumbar level but without features typical of either type of chondro-osteo-dystrophy.

FROM AN ATLAS OF GENERAL AFFECTIONS OF THE SKELETON

12. CRANIO-CLEIDO-DYSOSTOSIS

H. A. Thomas Fairbank, London, England

This congenital condition is characterised by deficient formation of the clavicles with delayed and imperfect ossification of the cranium, associated in many cases with other anatomical errors. The first case of clavicular defect is said to have been reported by Martin (1765). One, with both clavicles and the skull affected, was reported in 1871 by Scheuthauer. Marie and Sainton (1898) named the condition hereditary cranio-cleido-dysostosis and called attention to irregularities in the dentition. For long it was thought that the changes were confined to bones that normally ossify in membrane but, in fact, bones preformed in cartilage are often affected.

In view of the widespread and variable abnormalities discovered in cases that might be regarded as belonging to this group, Rhinehart (1936) suggested the alternative title of mutational dysostosis—a suggestion that was supported by Soule (1946)—but this seems to be much too comprehensive a title. Three valuable reviews of the subject have been published by Fitzwilliams (1910), Fitchet (1929) and Soule (1946).

Hereditary and familial influences—Heredity undoubtedly plays an important part in the incidence. Stocks and Barrington (1925) found that the condition was inherited in more than half the cases they collected, namely in ninety-six of a total of 144. It has been traced through five generations (Soule 1946) but it is said as a rule to disappear after two or three generations. It may be inherited through either parent with about equal frequency. Soule, combining Fitchet's figures with his own, found that in a total of 323 cases 198 were familial, these occurring in fifty-two families, while 125 cases were sporadic.

Sex—Both sexes are affected to an approximately equal extent.

Age—It may be discovered at any age. The cranial deficiencies may be noticed at birth. Fitzwilliams' cases included a baby one month old and a woman of sixty years. The defective clavicles cause little if any disability and may easily escape notice for many years but nearly 70 per cent. of the reported cases were discovered before the age of twenty years.

Etiology—The cause of this primary error of development is entirely unknown. It is one of the conditions that Jansen (1921) attributed to increased intra-uterine pressure, but his theory has not been generally accepted. There is no doubt that the development of the clavicles must be disturbed at a very early stage of foetal life. It has been discovered in a twin, a girl, the other twin, a boy, being normal.

Distribution of the abnormalities—This shows considerable variation. The clavicular error is present almost without exception and is usually accompanied by deficiency of the cranium. Defects in the skull appear to be always symmetrical. As to the clavicles, one or both may be defective. Fitzwilliams found a unilateral defect in only six of sixty cases. Stocks and Barrington found bilateral defects in 82 per cent. of their cases; only two patients, both with typical changes in the skull, had normal clavicles. Other sites of developmental errors are the teeth, the mandible, the hands and feet, the pubis, the femoral necks and the neural arches. Paltauf (1912) seems to have been the first to note the gap in the pubic symphysis. Crouzon and Bouttier (1921) suggested that a case with deficient ossification of the pubis be labelled *forme cleido-crânio-pelvienne*, while Latham (1945) proposed the term cranio-pubo-dysostosis for a case with normal clavicles.

Clinical signs—The striking features of a typical case are the slender build, the large head with small shrunken face, long neck, drooping shoulders and narrow chest. Growth of the whole skeleton is retarded and there may be a certain degree of dwarfism, but this is not a

marked feature as a rule. The mentality is normal. In at least one-third of the cases the skull shows well-marked frontal prominences separated by a median gutter. The parietal bones and sometimes the occipital bone may also form prominences, making six bosses in all on the skull (Stocks and Barrington 1925). The orbital ridges are well marked but the lower margins of the orbits are shrunken or even deficient. The anterior fontanelle is large and may never close completely. In some of the younger patients a much greater deficiency in the calvarium is seen. The eyes are rather far apart. The palate is high. A mild degree of hydrocephalus may be present. The maxillae are small so that the relatively large mandible may be prognathous. Delayed eruption, non-eruption and incomplete development of the permanent teeth are common. The temporary teeth erupt well and may be retained longer than normal; but when they are shed the retention of permanent teeth within the jaws may necessitate the wearing of dentures. Supernumerary permanent teeth are sometimes present. Dentigerous cysts may occur.

As a rule, the defects in the clavicles are easily felt. Sometimes there is no more than a kink in the middle of the bone or merely a dimple of the skin. The position of the shoulders —low and a little forward—and their abnormal mobility are no more than would be expected. Though the muscles may be defective in some anatomical details their power is not usually diminished. Many patients reach adult life entirely unaware of the defect in spite of hard manual work involving heavy lifting. Noticeable weakness of the shoulders and a tendency to undue fatigue are exceptional. When both clavicles are affected the shoulders can be approximated voluntarily in front of the chest to an abnormal degree and can be made to meet by gentle passive force. The scapulae may be small, somewhat deformed, rather winged and prominent, and more mobile than normal. Subluxation of the humeral head has been found in a few cases. The dislocation was complete in one case (Gross 1903), and could be easily completed by manipulation in another. We found both humeral heads subluxated downwards in a boy aged seven years. Bilateral subluxation of the radial heads has also been reported. Unusual length of the first finger is not uncommon. The fifth metacarpal may be shorter than normal. The terminal phalanges and the nails are short, particularly in the thumbs and great toes.

Other skeletal abnormalities have been found in individual cases. Postural defects and spinal curvature are common. Spina bifida occulta, often widespread in the spine, is of no clinical importance. Syringomyelia has been found as a complication. Widening of the symphysis pubis and deficient ossification of the pubic bones are not obvious clinically and even when sought are often not palpable. In younger patients the pubes are present, though partly or completely devoid of ossification. Coxa vara can be recognised by the usual signs. Other deformities that have been reported in individual cases are subluxation of a hip or a finger joint, and absence of the radius. In a case with deficiency of only one clavicle there was bilateral synostosis of the radius and ulna (Avery 1930).

Radiographic appearances—*Skull*—The membranous calvarium shows various degrees of imperfect ossification. The base is ossified normally. The sutures often fail to close normally. The anterior fontanelle is large and may never close; it may reach nearly to the level of the orbital ridges even in an adult. Occasionally there is a larger defect anteriorly, even in middle life. A fontanelle may be present posteriorly in both mastoid regions and also in the sphenoid. The mastoid itself may not be pneumatised (Salmon 1944). Wormian bones are seen in the occipital and posterior parietal regions. The frontal sinuses are often absent but occasionally they are disproportionately large, the other sinuses being small. In extreme cases there may be no ossification whatever in most of the vault. In one of our patients, aged three years, the two parietals were apparently unossified. The pituitary fossa may be small but it shows no constant change. The maxillae are hypoplastic but the mandible is of normal dimensions: fusion at the mandibular symphysis may be delayed or even fail to occur. There was no sign of fusion in a boy aged eight years reported by Ingham (1947). The mental tubercles

may be unusually long. The nasal, lachrymal and malar bones may be incomplete or absent (Salmon 1944). In some cases ossification of the skull is normal.

Clavicles—Stocks and Barrington (1925) found that the commonest defect was absence of the outer end of the clavicle, the sternal half being present. The next commonest condition was the presence of two separate fragments for each clavicle (28·2 per cent.—but this figure seems unduly low). The inner fragment was usually the larger of the two: the outer may not reach the acromion. The least common defect was absence of the sternal end with the acromial end present. Complete absence of both clavicles was uncommon (8·1 per cent.), and absence of one clavicle only was exceptional. These findings are supported, more or less, by other authors. Stocks and Barrington found pseudarthrosis between the two fragments in only three cases: the adjacent ends of the fragments in such cases may be enlarged or they may overlap. In only two of their cases, both with typical skull changes, were the clavicles normal. Nettesheim (1926) reported the case of a woman aged twenty-nine years with the left clavicle in three pieces and the right in two. Everley Jones (1937) rightly called attention to the need for care in examining radiographs since a clavicular fragment may easily be overlooked. In ten cases with clavicular defects this author found both clavicles represented by two fragments in all but one: in this there were two clavicular fragments on one side and only the sternal portion present on the other. The bones of the *limbs* generally are rather slender. In many of the recorded cases it seems probable that the pelvis and hips were not specially examined, so that the frequency of abnormalities in this region is uncertain.

Pubes—In most cases no reference is made to the condition of the pubes. In the author's small series of eleven cases, ten, varying in age from three to eighteen years, showed deficient ossification of the pubis, the deficiency being bilateral in all. In the other case—an adult woman—the pubes were well ossified; but her two affected children both showed defects of the pubes as well as other signs of dysostosis. The degree of deficiency was found to vary. In three patients there was complete absence of ossification in the pubes, both body and rami. The oldest patient of this group was a boy aged fifteen years who showed some stippling in the pubic part of the acetabulum. In six of the remaining seven cases there was a fragment of bone of varying size in the horizontal ramus, the body and descending ramus being completely unossified. Ossification of the pubis is only delayed; it occurs eventually, though often incompletely. The inferior ramus of the ischium shares in the delayed and defective ossification. The symphysis may remain unusually wide with an irregular boundary on each side. In such cases the fusion of the conjoint rami may be incomplete and their thickness considerably reduced. The case of a woman aged twenty-four years with these changes in the pelvis, and gross deficiencies in the clavicles, was reported by Steel and Whitaker (1937). Imperfect or delayed ossification of the pubes is not, however, invariably found in cases showing other clear signs of the condition. For instance, Fitchet (1929) published six cases in three generations of a family, in all of which the pubes were normal and there was no coxa vara. The pelvic ring may be reduced in size but seldom to a sufficient degree to cause trouble in childbirth. The sacro-iliac joints may be increased in width.

Coxa vara—In the author's series of eleven cases there was coxa vara in five—bilateral in three, unilateral in two. Both clavicles were deficient in four of these patients: the fifth had unilateral coxa vara and a defect of one clavicle, both on the same side of the body, while failure of ossification of the pubis was present on both sides. The type of coxa vara seems to vary. Klar (1906), the first to record this deformity, called the coxa vara in his case "congenital." But Ollerenshaw (1938) considered this type unusual. In his opinion the deformity occurred in the upper part of the femoral shaft and he had not seen coxa vara of the infantile type in the "many well-marked cases" of cranio-cleido-dysostosis he had seen. The author's experience differs from this, for in every case with coxa vara (a total of eight abnormal hips) the deformity was invariably of the infantile or cervical variety (Fairbank 1927, 1928). Soule (1946) said that infantile coxa vara was common. In Crouzon and

Bouttier's case (1921) the acetabula were deformed and the mobility of the hip joints was much increased.

Spine—Failure of union of the neural arches is common and may involve several vertebrae in the dorsal and lumbar regions. In one case we found spina bifida occulta from the sixth cervical to the sixth dorsal vertebra. In younger patients the vertebral bodies are inclined to be biconvex and the discs biconcave: in older patients they may show some reduction in depth. Various other congenital deformities of the spine, including half vertebrae and incomplete or complete absence of the lower part of the sacrum and coccyx, have been reported; but such exceptional findings are of little interest and of no diagnostic significance. Eltorm (1945) reported a curious case, a woman aged fifty-two years, with the dorsal bodies wedged *posteriorly* and showing defective ossification. The ribs may slope downwards to a greater degree than usual. The sternum may be of peculiar shape: failure of the manubrium to ossify has been recorded.

Hands and feet—In the hands and feet, various abnormalities have been found, the most constant and curious being the presence of epiphyses at both ends of the metacarpals and metatarsals, particularly of the second and fifth, and an abnormally long second metacarpal. The epiphysis which occurs at the base of the second metacarpal is strikingly large. The ungual tuberosities are poorly developed or absent, the terminal phalanges being short and pointed, particularly in the thumb and great toe (Brailsford 1935). The intermediate phalanges may be small; they may show curious ossification or even be absent. Ossification of the carpus may be delayed. The calcaneum may be short.

Complications—Pressure on the brachial plexus, relieved by removal of the outer fragment of the clavicle, was reported by Poynton and Davies (1914). One patient who complained of pain and numbness in the ulnar area, accompanied by cyanosis, was treated by bone-grafting operations on both clavicles (Everley Jones 1937). Ollerenshaw (1938) reported two cases, a brother and sister, with calcification in the skin and soft tissues. Syringomyelia has been mentioned already as a rare complication.

Pathology—There is no abnormality in the bone of the calvarium and clavicles except the limitation of its distribution. The base of the skull is said to be narrowed, especially in the middle portion. The cranial bones are thickened where bosses occur. The muscles acting on the shoulder girdle show a number of abnormalities varying with the type of clavicular deficiency (Fitzwilliams 1910, Everley Jones 1937). Their relative frequency corresponds broadly with that of the various deficiencies of the clavicle. The commonest are absence of the clavicular portion of the trapezius and the anterior fibres of the deltoid. Occasionally the sterno-mastoid and pectoralis major are deficient, but the clavicular parts of these muscles are affected only when the sternal part of the clavicle is very small or completely absent—a rare occurrence. When the sternal portion alone is present the bone is prolonged outwards by a ligament or fibrous band which in most cases passes to the coracoid and not to the acromion. The ligament may even be attached to the glenoid or to a rib (Fitzwilliams): it is regarded as the costo-coracoid membrane. When there are two fragments these are usually united by a ligament.

Diagnosis—This should present no difficulty. Absence of ossification of the pubis may be of diagnostic value. If found by accident it may lead to the discovery of deficiencies in the skull and clavicles. In a young patient showing pseudarthrosis of a clavicle, with thickening of the fragments, and without obvious deficiency in the skull, radiographic examination of the pelvis might remove any doubts as to the case being due to an error of development and not to trauma. Evans (1924) reported the case of an infant with an absent tibia and complete absence of ossification in the femoral head on the same side and in the pubis on both sides. The condition of the clavicles is not mentioned but the skull appears to have been normal.

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CASE 23
CRANIO-CLEIDO-DYSOSTOSIS

(Fig. 66.) Tracing of the radiograph published by Steel and Whitaker showing the wide symphysis and imperfect ossification of the pubes and conjoint rami in a woman of twenty-four years. There were deficiencies in the skull, and absence of the outer two-thirds of both clavicles.

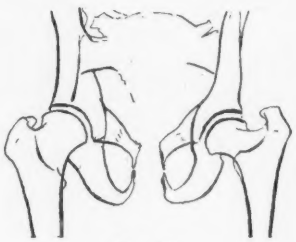


FIG. 66.

CASE 24—CRANIO-CLEIDO-DYSOSTOSIS

(Figs. 67–73.) Male, aged seven years. One of a family of seven children, the others being normal. Has always presented the same general appearance with large head and narrow shoulders. Typical changes in the skull, clavicles, pubes, hands and feet. Anterior and temporo-parietal fontanelles patent and membranous; frontal and parietal eminences prominent. Marked frontal fissure. No sign of frontal sinuses which should be visible at this age. Wormian bones in the occipital region. Lambdoid suture closed. Teeth very irregular. On extraction of carious temporary teeth there was practically no absorption of the roots. The shoulders can be "bunched together." The right shoulder droops more than the left; radiographs showed that the humeral head was subluxated downwards.

FIG. 67

Case 24. Large head, small face, narrow shoulders and chest, slender build generally. Note that the head of the right humerus is lower than the left.

FIG. 68

Case 24. Posterior view — small and markedly winged scapulae.

FIG. 69

Case 24. Antero-posterior radiograph of the skull showing the large anterior fontanelle. The metopic suture is widely open in its upper two-thirds.

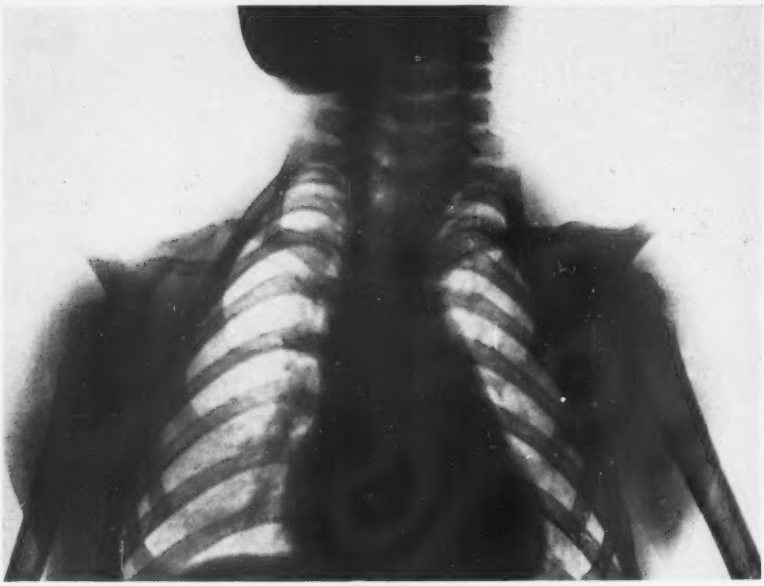


FIG. 70

Case 24. Chest and shoulders showing the narrow thorax. The right clavicle is represented by two fragments and the left clavicle is deficient in its outer part where it fails to reach the acromion.

FIG. 71

Case 24. Hand showing delayed ossification of the carpus, epiphyses at the bases of the second and fifth metacarpals, and abnormal shape of the intermediate and terminal phalanges.

FIG. 72

Case 24. Feet showing additional epiphyses at the bases of the second metatarsals. The shape of the internal cuneiforms and of the phalanges, particularly of the great toes, is abnormal.

FIG. 73

Case 24. Pelvis and hips showing absence of ossification in the bodies and descending rami of the pubes, and delayed ossification in the inferior rami of the ischia. The horizontal pubic rami are represented by oval fragments of bone.

CASE 25—CRANIO-CLEIDO-DYSOSTOSIS

(Fig. 74.) Female with bilateral clavicular dysostosis, each clavicle being represented by two fragments. Skull apparently normal (but not radiographed). Pubes ossified but distinctly less dense than the rest of the pelvis. No coxa vara. The width of the symphysis is approximately normal. The patient had three children, two affected by dysostosis: both had bilateral clavicular dysostosis, all four clavicles being in two fragments. In the elder child, a boy aged twelve years, there was no ossification of the pubic body or descending ramus on either side, whereas the horizontal rami consisted of bone; there was coxa vara on the right side only; the only abnormalities in the skull were absence of the frontal sinuses and presence of Wormian bones in the occipital bone. The younger child, a girl, showed similar bilateral delayed ossification of the pubis but no coxa vara.

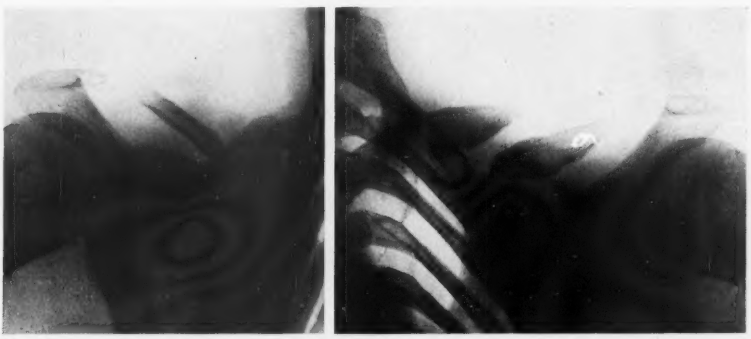


FIG. 74

Case 25. Each clavicle is represented by two fragments. Note that the outer fragments do not reach the acromia. On the left side the two clavicular fragments overlap.

CASE 26—CRANIO-CLEIDO-DYSOSTOSIS

(Figs. 75 and 76.) Female, aged six years. Always weak on legs: gait waddling. Lordosis present. Skull generally well ossified. Wormian bones in the occipital region. Bilateral division of the clavicle into two fragments. Bilateral coxa vara, which radiographs showed to be of the cervical or infantile type. Subtrochanteric osteotomy performed on both femora. The body and descending ramus of the pubis, and the ascending or inferior ramus of the ischium, are unossified on both sides. The horizontal rami of the pubes are ossified. On palpation no deficiency can be felt in the pubic region. Additional epiphyses and other changes present in the hands. The terminal phalanges of the toes, particularly of the great toe, are typical.

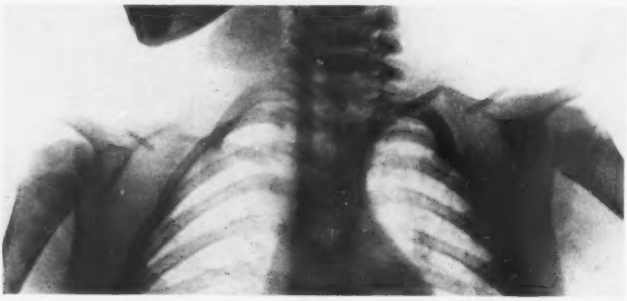


FIG. 75

Case 26. Thorax and shoulders showing both clavicles in two fragments, the outer being smaller and not making contact with the acromion.

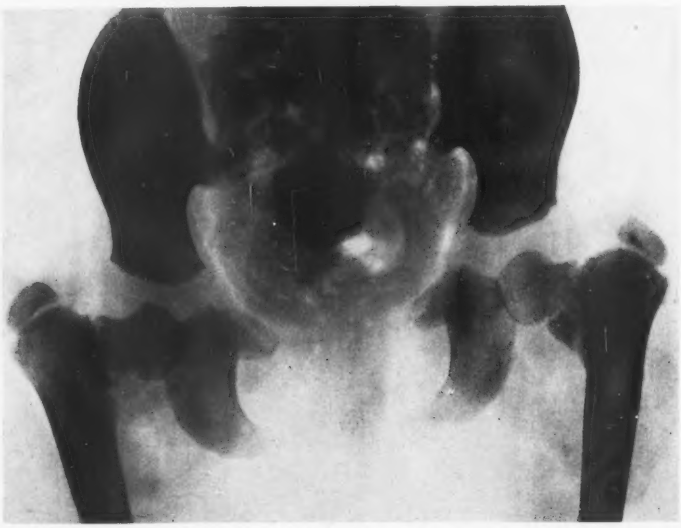


FIG. 76

Case 26. Pelvis and hips showing absence of ossification in the bodies of the pubes and the conjoint rami, and typical infantile coxa vara of both femora. Note that the horizontal rami of the pubes are ossified.

CASE 27—CRANIO-CLEIDO-DYSOSTOSIS

(Figs. 77–80.) Male, aged three years. No abnormality noticed by the parents. Fourth of four children, the others and the parents being normal. Gross deficiency in the calvarium; the parietals show little if any signs of ossification; anterior fontanelle very large. Two fragments for each clavicle. Epiphyses at both ends of all metacarpals. Ossification of carpus delayed. Both pubes completely devoid of bone. No coxa vara. Delayed fusion of mandibular symphysis and of neural arches of the spine. The density of most bones is below normal. (Under Sir L. Barrington-Ward.)

FIG. 77

FIG. 78

Case 27. Skull showing enormous fontanelle, limited union of the two halves of the frontal bone, and absence of fusion at the mandibular symphysis (Fig. 77). In the lateral view note the gross deficiency in ossification particularly of the parietals, and many Wormian bones in the occipital (Fig. 78).

FIG. 79

FIG. 80

Case 27. Pelvis showing complete absence of ossification in the pubes and inferior rami of the ischia (Fig. 79). The lower forearm and hand (Fig. 80) shows osteoporosis of the bones, double epiphyses for all metacarpals, and a curious shape of many phalanges.

IN MEMORIAM

THOMAS PORTER McMURRAY, C.B.E., M.Ch., F.R.C.S.

1888-1949

The suddenness with which we have lost the alert vitality of T. P. McMurray with his boyish good humour, tall, handsome presence, and perpetual appearance of youth is difficult to believe. Until recent months he was still teaching post-graduate students from Australia, Canada, South Africa and many other parts of the world, and only a few days ago when the Hugh Owen Thomas Lecture was delivered in Liverpool he welcomed " a lost sheep " back to the fold. He died from a heart attack in London on November 16, while on his way to South Africa to visit his son.

Born in Belfast, McMurray graduated in medicine at Queen's University in 1910 and the next year went to Liverpool as house-surgeon to Sir Robert Jones. In 1914, after serving for a short time in France as captain in the R.A.M.C., he was recalled to the Alder Hey Military Orthopaedic Hospital in Liverpool where many English, Canadian and American surgeons were trained by Robert Jones and worked with him. McMurray's clinical appointments at the David Lewis Northern Hospital, Royal Liverpool Children's Hospital

and Ministry of Pensions Hospital were coupled with University teaching appointments first as lecturer and then, in succession to Robert Jones, as director of orthopaedic studies. When a chair was established in 1938 he became Liverpool's first professor of orthopaedics, and after upholding the traditions of Hugh Owen Thomas for a quarter of a century he was made emeritus professor last year. He was honoured by the presidencies of the British Orthopaedic Association and the Liverpool Medical Institution, and was president-elect of the British Medical Association.

He was essentially a good companion. Whether in the operating theatre where none was immune from his wit, on the golf links where he sank ridiculously long putts without appearing to look at the ball, at home playing cards where he always seemed to win, or at a fair throwing at coconuts and smashing a whole stand of crockery for an outlay of half a crown, he was great fun. When doing nothing he did it thoroughly, and to see him sitting in the sun at his beloved Ystrad "cottage," gazing at the Denbighshire hills, was an education in relaxation. His kindness was warmed with an emotion that he himself would have denied. For six years after the loss of his first wife he was a very lonely man; but then the wound healed and after marrying again he enjoyed life more and more. To his wife and daughter, and to his son now practising orthopaedics in South Africa, we offer our deep sympathy.

In McMurray was exemplified British reluctance to commit clinical observation to writing until confirmed after many years. His writings were therefore few, but they were important. Some may still find difficulty in eliciting his sign for posterior horn tears of the meniscus, and others may wonder why oblique displacement osteotomy avails in the treatment of osteoarthritis of the hip, but none may discount his conclusions which were based so firmly on long observation.

His dexterity as an operator is almost legendary. Many have seen him remove a meniscus with the whole of its posterior horn in less than five minutes, and recent American visitors spoke of the fleetness of foot that was demanded of assistants chasing round the operating table when a hip joint was disarticulated in little more than ten minutes. But it was the consummate skill and artistry of his technique that was even more impressive than the speed of it; the speed was indeed "an achievement and not an aim."

It is as a teacher that McMurray will be remembered. He was forceful, dogmatic, and even intolerant if the principles of Hugh Owen Thomas were denied. "You've read that in a book" he would say with reproof. He was not an orator, but his words will long be remembered: "Feel it laddie"; "I think you're splendid"; "Get on with it laddie"; "You're a credit to us." The building up of a great postgraduate school of orthopaedic studies, with the M.Ch.Orth. degree of the University of Liverpool, is the permanent contribution he made to the surgery of his generation. It is difficult to know the full extent to which he maintained and enhanced the Liverpool tradition of orthopaedic surgery but a measure of it is in the words of his old students, from the four quarters of the world, inscribed in a recent presentation volume:

"This book is signed and presented by your old students as a symbol of their respect and affection and to record for ever the debt they and their country owe to you. By your skill and by your teaching you have enhanced a great tradition: this is now our treasured heritage and by our deeds we will preserve it."

B. McF.
R. W.-J.

ROBERT MILNE, M.D., M.S., F.R.C.S., L.M.S.S.A.
1881-1949

Robert Milne, son of Dr Milne of Inverurie, was born in 1881 and educated at the City of London School. He began his medical studies at the London Hospital eighteen years later. The many scholarships and prizes he gained showed his calibre. Taken by themselves they were impressive enough, but in the light of the opposition he had to face they were doubly so, for these were the embryo days of the growing distinction of the London Hospital. His friends and contemporaries included the surgeons Russell Howard, Richard Warren, Frank Kidd, James Walton and Henry Souttar, and among those who were to be distinguished in pathology and medicine were Hubert Turnbull, Theodore Thompson, Charles Miller and Letheby Tidy.

He qualified in 1904 at a time when a man could hold appointment after appointment, year after year, so that whatever speciality he might adopt later his foundations were sound and secure. This Robert Milne did. He held appointments in general medicine, surgery, gynaecology and obstetrics, served in the casualty and out-patient departments, and was resident anaesthetist and assistant in the ophthalmic, ear, nose and throat, and orthopaedic departments. In 1910 he was appointed sixth assistant surgeon, and joined forces with Hugh Rigby in the firm of " Rigby & Milne." His appointment as Teacher of Elementary Clinical Surgery in 1914 was restricted by absence on military service when he served as a major in the R.A.M.C.

In 1922 Tommy Openshaw retired and Robert Milne inherited the Orthopaedic Department of the London. As the treatment of fractures remained in the hands of the general surgeons, few came under his care, but he set a high standard. Not unnaturally, considering his contacts in the first war, he favoured the methods of Meurice Sinclair and really knew how to use them. He could almost make a Thomas splint talk and he was an artist with Sinclair's glue. A bandage in his hands was no mere swaddling; it exercised real control where he wanted it. Let it not be thought that he was a conservative diehard. His work and hospital were almost his only interests and he was always on the alert for new things.

That he did not find as many as might have been expected was because his encyclopaedic knowledge of what had gone before often showed him that the latest marvel was no more than an old dodge resurrected.

His clinical memory was astounding and social recollections often hung from a clinical peg. " Ah, boy," he would say, confronted by a half-remembered face. " Yes, yes; Princes Risborough, 1913 wasn't it; you fell off your horse into a pigsty and we fixed your fractured femur in a Thomas splint that the blacksmith made from an old iron bedstead? " Thus were the years spanned and to him the " History " really mattered—an aspect of medicine that he taught assiduously to generations of students.

In one other respect Robert Milne was outstanding. He had a vast and detailed knowledge of every type of industrial activity. If a patient said that he was a " radial driller " Milne knew his work exactly. How great an asset to one whose life was devoted to the restoration of function, and how much it contributed to his judgment!

Between the wars Milne became ever more busy, succeeding his father as consulting surgeon to Dr Barnardo's Homes, serving on the Court of Examiners of the Royal College of Surgeons, examining for the University of Cambridge and the Society of Apothecaries and attending at the London Hospital where his clinics and operating theatre were always packed with students and postgraduates.

In 1942 came the day of his retirement. But the limbo of oblivion was not for him. The next day, having shaved off his moustache with what unknown pangs, he appeared in the uniform of a surgeon rear-admiral. From then he was consultant to the Royal Navy and after early falterings as to who saluted whom and when, he was accepted into its family circle.

Kindly, generous, courteous and human, it was impossible not to like him. His impish sense of humour could never give offence. He was modest and unassuming; he wrote little; and it is to be regretted that he hid his light under the bushel of the London Hospital. Those who worked with him remember the great debt they owe. At the age of sixty-eight, while still in full vigour, he played a round of golf, and quite suddenly was spared the sorrows of failing health. To his widow and three children the most sincere sympathy of all who knew him will go out.

O. J. V.-J.

GABRIEL NOVÉ-JOSSERAND
1868-1949

By the death of Professor Nové-Josserand of Lyons on October 15, France has lost one of her greatest leaders and pioneers in orthopaedic surgery. He was honoured the world over. His pride and joy when awarded the Honorary Fellowship of the Royal College of Surgeons of England in 1933 was witnessed by this writer and will never be forgotten. Until the very end, he was eager to know of the latest developments of orthopaedics in Great Britain.

He was born in the vicinity of Lyons in 1868 and devoted a busy life to the treatment of disabled children in that city. In early days at a secondary school, and throughout a remarkable University career until the highest degree in the Faculty of Medicine had been gained, he won every single prize that was offered. As a pupil of Leopold Ollier he acquired interest in bone surgery and the physiology of epiphysial growth. After beginning practice as a general surgeon he was appointed head of a service in the *Hopital de la Charité* at the early age of twenty-nine, which is unusual in France. At that hospital there were some fifteen or twenty children suffering from congenital deformities and this was the turning point in his career. One of the first surgeons in France to conceive of orthopaedics as a special branch of surgery, he shared with Muirhead Little, Openshaw, Elmslie, Bankart and other British colleagues the task of winning for our specialty the recognition it now commands.

GABRIEL NOVÉ-JOSSERAND
1868-1949

Never sparing time or effort, and with ceaseless attention and steadfast devotion to his Service, he became established as a leading pioneer. From Vienna he brought to France the teachings of Lorenz on congenital dislocation of the hip. His own contributions included a technique for the treatment of congenital club-foot, an operation for congenital malformations of the urinary tract, the first arthrodesis for coxalgia, and monographs on coxa plana, infantile paralysis of the knee, and deformities of the foot that are still worth reading.

During the 1914–18 war he served as specialist with the rank of colonel and organised a service for the restoration of disabled soldiers in civil life—one of the first of its kind in France. In 1920 he was appointed the first Professor of Orthopaedic Surgery in the University of Lyons. He presided over the French Orthopaedic Society in 1922; and ten years later, in London, was made president of the International Society of Orthopaedic and Traumatic Surgery—a tribute to long and splendid service.

He was a great teacher. Generations of medical practitioners and many well-known orthopaedic surgeons gained stimulus and inspiration from him. Lectures were planned with unusual care and particular attention to detail, and demonstrations were made effective by the skill with which he handled children and the precision and conciseness of his diagnosis.

Gabriel Nové-Josserand was a magnificent figure, tall, lean, composed and with a stately bearing. His private and family life was characterised by quiet dignity. By nature he was silent and reserved; he never uttered an observation that was not deeply matured; and his authority was based on supreme integrity and wonderful modesty. After retirement a few years ago he maintained a keen interest in the development of orthopaedic surgery, with a mind that was still open to new and original thought. A long and painful illness was met with unflinching courage and composure. He was a great surgeon and a great man. W. B.

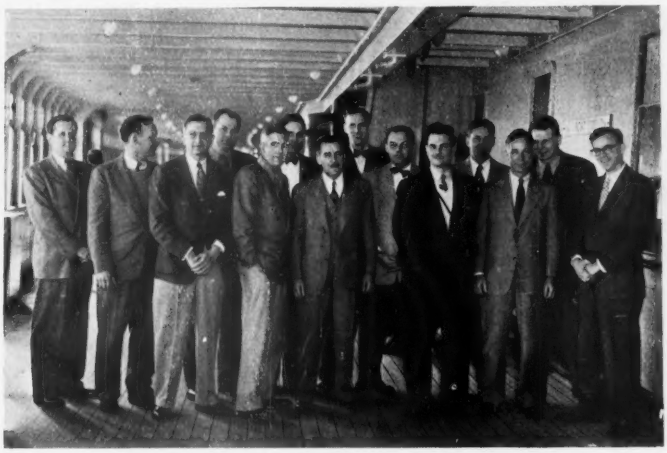
PROCEEDINGS AND REPORTS OF UNIVERSITIES, COLLEGES, COUNCILS AND ASSOCIATIONS

UNITED STATES OF AMERICA, CANADA AND GREAT BRITAIN

THE SAGA OF THE "DEEP FREEZE"

AN AMERICAN VIEW OF CONTEMPORARY BRITISH ORTHOPAEDIC SURGERY

The American orthopaedic group arrived at Southampton on March 22. With customary British efficiency, we were whisked through customs by representatives of the British Orthopaedic Association and on into London. There began the most concentrated period of instruction, clinics, lectures, sight-seeing and entertainment that the British could conceive. In the next six weeks we were whirled through the length and breadth of Britain in a bus affectionately named the "Deep Freeze." We visited some thirty-three hospitals and six rehabilitation centers in eighteen cities. An appraisal of contemporary British orthopaedic surgery, consequently, is not at all presumptuous. Elaboration and detail would make a large and delightful volume and still be only a synopsis of the astonishing number of instructive and



The American and Canadian travellers in orthopaedic surgery, who are joint contributors of this report on contemporary British orthopaedics, photographed on board the "Queen Mary."

entertaining features of this trip. We wish that every young American orthopaedic surgeon could ride the British surgical carousel; it is doubtful, however, if a group a decade or so older could survive the terrific pace of British hospitality. We are tremendously grateful to our British hosts and hostesses; we are thrilled with admiration for their scientific accomplishments; we are happy to know, personally, our British contemporaries in orthopaedic surgery.

During the trip it was difficult to appraise and digest all the information properly. The tendency to see the leaves rather than the trees in the Sherwood forest, produced "deep-freeze" conversation of an exaggerated character which might well have disturbed British-American relations. A sufficient period of time has now elapsed for proper rumination and reflection. Certain features of the trip have become hazy but very pleasant memories, and the outstanding performances will never be forgotten. We are quite convinced that British orthopaedic surgery is superlatively "well done."

What is the difference between British and American orthopaedic practice? Basically and fundamentally there's very little difference. The problems are much the same and the over-all approaches are essentially similar. "You'll find that many of our orthopaedic problems are not handled as well as in America, but our trauma is better handled." That British opinion would find considerable American support; others would reverse it. A view of both countries shows that social, economic and medico-legal factors dictate some of the differences. Hospitals, equipment, physical resources, and even socialized

Some of the boys outside—

—and inside the " Deep Freeze."

medicine play a part. If these factors are eliminated there's only a small residual pot-pourri of provocative subjects. On some of these we disagreed among ourselves as much as with our British hosts. In general our British friends are a bit less surgical-minded than we in their approach to a few orthopaedic and traumatic problems.

Not all the advances and knowledge of medicine have occurred in the past half century. A stroll through the museums of the Royal Colleges of Surgeons at London and Edinburgh reveals a wealth of enviable anatomic and surgical specimens. The original works of such great men as Hunter, Pott, Paget and Harvey leave one in awe and amazement—almost reverence. The British surgeons have a tremendously rich heritage; their anatomists are among the best. Their rather numerous references to great men of the past are now not only understandable but commendable.

In addition to their skill as surgeons and anatomists we were impressed by their ability as first-class speakers and orators, either at social functions or scientific sessions. This is certainly one small facet that Americans have neglected. At the British orthopaedic meeting in Nottingham, it was a treat to hear men talk in a clear, concise manner and present their subjects clearly without notes in the allotted time. Verbosity is reserved for social functions, particularly the after-dinner speeches.

The hospitals in Britain were of two extremes: either old, chilly structures with high ceilings, or extremely modern and up-to-date buildings. Obviously in every instance the surgeon conferred with the architect, for the operating theaters were well planned and very large. Some were, in fact, of "movie set" material, namely, beautiful tile, excellent taste in colors and gorgeously equipped. The many open-ward hospitals reflect the influence of Sir Robert Jones and Dame Agnes Hunt. We wondered if the capillaries of the attendants ever expanded to normal. One had to admit that they all looked superbly healthy and didn't seem to mind the cold. In fact the lack of central heating in most hospitals and homes didn't seem to inconvenience anyone (but the visitors).

The geography of Britain lends itself to well-organized clinics scattered radially about the principal orthopaedic centers. Their cases are followed in a very detailed manner by both surgeons and clinic nurses. The average orthopaedic follow-up nurse in Britain is a well-trained orthopaedic assistant who has considerable ability, experience and knowledge. The clean, neat wards and well-cared-for patients, particularly those with chronic disease, speak well for British orthopaedic nursing. Soiled appliances or apparatus were a rarity.

Rather than run the gamut of orthopaedic surgery, we've picked a few subjects in which our group was particularly interested. Poliomyelitis is not included for it is not a major problem in Britain; nor were any well-organized efforts observed in behalf of cerebral palsy; neither do we mention slipped upper femoral epiphysis, since we couldn't even agree among ourselves as to the details of proper therapy. All of our group have contributed and, in the main, concur in the following syllabus.

Congenital Anomalies

Discussions on congenital dislocation of the hip were held at some half-dozen centers. The method of treatment varied slightly in the different clinics visited but, in general, was similar to the methods favored in America. In the infant patient, closed reduction under general anesthesia, with or without a preliminary period of traction, was the most common procedure. Subsequently, immobilization was carried out by means of a plaster cast with the legs in the frog, or 90–90, position. The change to the secondary position of internal rotation was usually delayed a little longer than is our practice, namely, between three to six months after the primary reduction. At a few centers the Batchelor splint with traction was used to obtain a gradual reduction by abduction and to provide fixation thereafter for a varying period. Final fixation was ordinarily secured by a plaster cast.

We found few advocates of derotation osteotomies or of primary open reduction, this latter procedure being reserved for resistant or older conditions. Shelf operations were highly favored and many were done at an early age. Pre-reduction arthrograms with radiopaque material were being made with great frequency in many of the clinics and provided some very definite clinical information, but added little to definitive treatment.

Treatment of the older patient with unreduced dislocation and resultant pain is much the same on each side of the Atlantic. Most of these patients come to osteotomy or some other type of reconstruction operation and with very similar results to our own.

Congenital club-feet were seen in about the same frequency in Britain as at home, and because of well-organized and well-distributed orthopaedic clinics, most patients received treatment early in life. In general it was our impression that the treatment of the early defect in Britain differed considerably from the current methods being used in America. Mild deformities are treated by repeated manipulation, frequently at home, with intermittent fixation either by adhesive strappings, a cast, or the Denis Browne splint. Application of the latter was not carried out unless the foot could be passively corrected to the neutral position. When this was not possible, application of the splint was preceded by manipulation with the patient under anesthesia. The plaster wedging method of Kite which has become so generally accepted in this Continent was not in use at any of the clinics that we visited. The more resistant and difficult conditions were usually treated by forceful manipulation or an open operation, and we thought that the Kite method would be a very beneficial addition to their armamentarium. Forceful manipulation, as with our early experiences, left much to be desired; it left a rather inflexible, broad, short foot.

The older, recurrent and resistant condition of the feet became operative problems. Medial soft-tissue excision operations combined with lengthening of the heel cord or posterior capsulotomy or both have given some gratifying results, and some older conditions come to arthrodesis.

Tuberculosis

Tuberculosis is much more common in Great Britain than in North America and presents to the British medical authorities a major problem in hospitalization and care. In fact, more stringent public health measures to control the dissemination of tuberculosis would seem to be in order. Every orthopaedic center carried a heavy burden of these patients and many open-air hospitals were available exclusively for tuberculosis.

Great stress is laid upon constitutional therapy, rest, good food and fresh air. An ample supply of the latter is guaranteed in all weather conditions by the design of the wards, and the response of both patient and physician to this treatment is most enthusiastic.

Simultaneously the local lesion is splinted. Joints are protected against weight-bearing and all but a minimal amount of motion. Most children with involvement of the vertebrae or lower limbs are nursed on a Jones abduction frame or on one of its many modifications. Plaster beds are more favored in adult work. These are beautifully made, and special turning devices and counterbalancing methods minimize the arduous task of nursing.

Attention was called to several cases of premature fusion of the epiphyses about the knee joint in association with long-continued immobilization of a limb for disease of the hip joint. Renal calculi were not a problem.

When the local and general reactions are favorable, the indications for operating upon the patient are reviewed. Fusion across the joint is done primarily to maintain stability and is accepted for the hip and knee with greater alacrity than for the spinal column. This is difficult to understand. A somewhat earlier fusion performed to immobilize the involved segment of the spinal column during the more active stages of the disease is not regarded as beneficial. The arguments against such a procedure are not convincing. In addition the period of conservative treatment prior to fusion seems unduly long.

British surgeons have developed a rational method of treating Pott's paraplegia; timely interference by lateral decompression should be more thoroughly understood at home. While some fatalities have resulted from tuberculous meningitis, this is not an overpowering risk in the face of such a dread disease. The relief obtained in a majority of cases was most impressive. The supply of streptomycin is too small for any extensive experience in its use.

Scoliosis

Our contact with the problem of scoliosis was casual. No large, well-organized clinics for the care and treatment of these patients were in evidence though such organizations are forthcoming. There is a great opportunity for leadership in this field.

Equalization of Leg Lengths

The problem of equalizing discrepancies in leg lengths was discussed in some detail at two centers. Leg lengthening, usually of the tibia, was chosen as the surgical procedure to achieve this equalization. Both centers presented large series of cases demonstrating excellent surgical technic, as revealed by the attainment of good length and bony union. There were, however, complications, such as transient nerve palsies, valgus deformities of the ankle and limited motion of the knee. Leg shortening was performed only occasionally. It is our impression after observation of their results that leg lengthening should not be totally discarded; it may be used in instances in which considerable inequality is present and attacking the sound extremity alone would not accomplish sufficient improvement.

We were surprised that epiphysial arrest was so seldom considered. This method has proved its value in America. The surgical risk is minimal, and prolonged hospitalization and disability are reduced. We believe that the objection to interfering with the normal extremity and the decrease of stature has been overemphasized in Britain.

Surgical Treatment of the Painful Hip

The attention devoted to the surgical treatment of painful hips (malum coxae senilis, traumatic arthritis, old slipped epiphysis and so forth) was evidenced by organized discussions of the problem in more than half the centers visited. The surgical procedures in common use were arthrodesis, osteotomy, excision of the head and neck of the femur and cup arthroplasty. Indications for each were not always clear and the choice seemed to rest with the preference of the individual surgeon. Representative patients treated by the various procedures were shown to us and on the basis of our observations, we formulated fairly definite impressions.

Arthrodesis of the hip was the most favored operation. This favored position was based on the high percentage of painless stable hips. However, bony ankylosis was not always obtained and many patients had residual limitation of knee motion from plaster immobilization. In each clinic where arthrodesis was advocated, technical modifications were presented to produce fusion more certainly and to get away from plaster immobilization. A future study of end-results must yet tell us whether any technic to date will allow earlier ambulation and obviate plaster casts.

Subtrochanteric osteotomy of the femur had a very wide appeal in the treatment of painful hips. We saw the results of the McMurray type more frequently than any other and the results varied widely; in general, the pain was relieved at least in part, and the range of residual motion diminished in proportion to the number of years after operation. Some surgeons preferred what was termed a controlled osteotomy. The operation was applied to realign the extremity in cases in which a painless range of motion existed if the hip was tested in the position of deformity. Internal fixation was used to avoid plaster immobilization. The results observed in this limited group were impressive, and the hip joints were functionally good as long as eight years after operation. One distinct drawback existed—that of non-union at the site of osteotomy. Several such cases were shown us and, with bridges burned, it was difficult to suggest further treatment.

Excision of the head and neck of the femur for the treatment of a painful hip was carefully presented to us in several centers. Since this was not a common procedure in America, we were extremely interested in seeing end-results. It was encouraging to note the amount of stability and the range of painless motion that was accomplished by surgical excision of the joint. The stability was enhanced, on many occasions, by the use of a trochanteric osteotomy allowing the trochanter to parallel the direction of the acetabulum. An insufficient number of such cases was seen to allow us to form any firm convictions, but it does seem well established that such a procedure is possible and justifiable, provided one does not hesitate to sacrifice a small amount of stability in order to gain a fair range of painless motion.

Mold arthroplasty of the hip has gained many supporters since it was taken up at the end of the war. It was impossible to judge the results except in single isolated instances, but the results were sufficiently good to warrant acceptance of the growing demand for a movable hip. There were many minor modifications of technic from the original described by Dr Smith-Petersen. By and large, the best results shown us were in those cases in which a very large, medially placed acetabulum had been made and a sufficiently large, freely movable mold had been applied.

It is obvious that the surgical treatment of the painful hip is far from standardized. This is just as true at home as it is abroad. There is a great need for evaluation of the surgical treatment of painful hips. With such a standard, it would be possible to compare the results of one type of operation with another and in the future establish more definite indications for each type of operation.

Trauma

When the methods commonly employed in the management of fractures in Britain were compared with those in America no essential differences were observed. Discussions within our group failed to sustain the oft-expressed impression that open reduction was less frequently the choice of treatment with our British colleagues. As in the United States and Canada, only a few centers in Great Britain practised strict non-touch surgical technic. It became evident during the tour that individual practice varied as much on one side of the Atlantic as on the other. While no radical new concepts of treatment were observed, many interesting solutions to fracture problems were encountered. In many centers the emphasis is on early function and minimal immobilization.

At several hospitals, series of fractures of the os calcis had been treated by open operation following the method described by Ivor Palmer. The early results did not show any increase in the range of motion of the foot as compared with patients treated by conservative means, and the period of disability was not shortened; the appearance of the foot, however, was almost normal. Observations on the late results in these cases will be of further interest. The more frequently observed treatment was that of early mobilization without any attempt at reduction.

Simple compression fractures of the spinal column are most commonly treated as we treat them, with reduction and immobilization in a position of hyperextension. However, in some of the mining districts where these injuries are very common, compression up to one-third of the height of the vertebral body is not reduced or immobilized. Active exercise and intensive reconditioning of the musculature of the back are prescribed at an early date. By this method, the period of disability was said to be reduced.

Fractures of the femoral shaft were almost universally treated by traction. A few cases of intramedullary fixation by a Kuntscher nail were shown. Early exercise and joint motion are encouraged. Fractures of the femoral neck are almost universally treated by internal fixation with a three-flange nail. In some centers, intertrochanteric fractures are fixed with a blade plate and in others traction is used. There is not the economic factor necessitating early ambulation and discharge from the hospital, because most of these elderly patients cannot go home until their fractures are healed.

Accident centers are well organized to provide excellent care. At one institution emphasis was placed on training younger men equally well in plastic surgery, general surgery, neurosurgery, and the handling of fractures; that is, they were trained to be rather good at all but not superlative at any. This approach, however, has many advantages.

The treatment of burns was carried out with an elaborate routine. The end-results were quite convincing that this detail paid off admirably.

Recurrent dislocation of the shoulder is a favored subject in Britain, and well it might be. We saw several demonstrations of the pathologic aspects of this condition and the two most popular technics for its repair, the Bankart operation and the Putti-Platt technic. The British were almost adamant in their adherence to these technics; perhaps they're right.

Hand Surgery—Peripheral Nerve Surgery

Surgical treatment of the hand is generally very well carried out, and some of the work we were shown was indeed superb. The best work was done in those centers where the patients with abnormal conditions of the hand were segregated under the care of an interested surgeon, or team, equipped to deal with all the tissues of the part. The treatment of crippled hands involves peripheral nerves and skin, as well as bones, joints and tendons, and the artificiality of tissue specialization is well demonstrated in this small but vital part where such varied anatomic structures are contained in so small an area that injury or disease does not confine itself to one type of tissue. Surgery of the hand is obviously a field which demands special knowledge and technic, and the surgeon who enters the field only occasionally and without adequate preparation must accept mediocre results in Britain as well as in America.

We were particularly impressed by the excellent work being done by a number of British orthopaedic surgeons on peripheral nerve injuries. In one center, we saw late results of nerve sutures and nerve grafts that were superior to any we had ever seen anywhere. In several hospitals, we were shown splendid examples of free and pedicle skin grafts applied to the extremities. We were impressed by the fact that orthopaedic and plastic surgeons often belong to the same societies and attend common meetings. Because of the frequency of combined skin, nerve, and osseous lesions of the extremities as well as of the hands, the impracticality in many instances of having a specialist for each tissue is obvious. We were much impressed by the desirability of giving the orthopaedic trainee more experience in plastic surgery of the extremity and in peripheral nerve surgery.

Rehabilitation

Sir Robert Jones' doctrine that orthopaedic care should consist of prevention, treatment and job-training has made an indelible impression upon the rehabilitation centers which were visited. Well-organized programs associated with hospitals, government and industry are producing results which justify a close study of the method employed. Four principal programs are offered: residential training schools, on-the-job industrial rehabilitation centers, rehabilitation centers for coal miners, and rehabilitation centers for amputees.

In the residential training schools, training is based on real production. The instructors are tradesmen and their aim is to produce a tradesman. The work selected is work which cannot be mass produced, such as boat-making, tailoring, brace-making, upholstery and so forth. Of interest is the experience with cerebral palsy patients who are assigned to simple upholstery work and mattress-making. Skill is developed and confidence is acquired, and the individual is completely happy in this simplification of his work. The aim is to persuade the disabled that he can overcome his handicap. Here is a program of normalizing the disabled person. Many of these individuals have been crippled all their lives, so on-the-job training is not applicable. Trainees are taken if there is a fair prospect that a reasonable standard of economic stability can be attained.

On-the-job training is stimulated by a rehabilitation team consisting of an orthopaedic surgeon, a plastic surgeon, a rehabilitation superintendent and his deputy and an industrial physiotherapist. This work is centered on a retraining shop run on standard production lines. Repetitive exercises as a means of restoring muscle power, range of motion and active circulation are obtained in the retraining shop by adding special equipment to operating levers of a machine tool. The special adapters used are the product of consultation between surgeon, engineer and patient.

Spectacular results of this type of rehabilitation are found in the excellent functional result obtained, the reduction of time lost from work, absence of psychoneurosis and improvement of industrial relationship between management and labor.

Such an elaborate rehabilitation is permissible only in a large industry. However, a similar plan for smaller factories has worked out very successfully where several smaller industries combined to contribute money, equipment and material for fabrication.

The centers for the rehabilitation of coal miners are seeking to reinstate the patient in the community at the highest possible level. A system of remedial exercises, occupational therapy, recreational therapy and social service has greatly increased the percentage of patients returning to useful work in the mines. These centers provide a magnificent opportunity to study the correct after-treatment of various injuries. It follows, therefore, that the clinical research reports based on these cases should be looked forward to and studied with interest.

A rehabilitation center for amputees manifested an admirable co-operation between the orthopaedic surgeon, the limb-fitting surgeon and the limb maker. This team insured the patient a suitable stump, prosthesis and training in its use.

Amputations

The surgical technics employed in major amputations of the extremities in Great Britain do not differ markedly from those employed in America, and the sites of election for amputation are similar to those employed here. The same criticisms of the Syme's amputation and of disarticulations are encountered in England as in the United States.

In contrast to the similarity of surgical procedures in amputations, there is a pronounced dissimilarity in prosthetic appliances furnished to the amputee. The procedures followed in the provision of artificial limbs to amputees in Great Britain are unique. In accordance with the trend to achieve complete nationalization of all industry, the design, manufacture and fitting of artificial limbs are centralized. One company has a monopoly on the construction of artificial legs and another controls the manufacture of arms and hands. The emphasis is on inexpensive, wholesale production which dictates the selection of materials that lend themselves to mass production. Metal is used almost exclusively for artificial legs. The inevitable result of mass production is standardization which is a definite disadvantage from the standpoint of the individual amputee. Mass production of legs in metal does not permit the delicacy of fitting so necessary in a socket. The cumbersome shoulder harness and the type of single axis knee, generally with a spring arrangement, cause poor walking and an awkward gait.

It is interesting to note that Great Britain along with most of the other countries of Europe does not furnish hooks for the arm amputees. While it is agreed that the split hook is the most useful type of arm prosthesis, its appearance is frowned upon. Therefore, in general, the arm amputee is furnished with a plastic hand with immovable fingers and a passively adjustable thumb. This is affixed to the stump through the use of a plastic or a metal-and-leather socket. The artificial hand is essentially a dress hand and not one designed for utility. For workers, the hand is removed and a series of tools may be affixed to the socket through a " quick disconnect." There is a great variety of tools designed and furnished to the amputee. These consist of special knives, forks, spoons, hammers, screwdrivers, holders for various working tools and special appliances for typewriting, drafting and personal care. These tools are intended to be placed conveniently in the home and in the workshop and, therefore, are quickly available to the amputee when he desires to use them. This solution to the problem of the arm amputee is in contrast to the one attempted in America where it is believed that a well-designed functional hook used with dexterity will permit the amputee to carry out most of the above-mentioned functions without constantly changing the tools on his prosthesis.

Postscript

We are now settled down in the States and in Canada in the complacent rut of routine practice—a haven of rest by comparison with the visit to Britain. A kaleidoscopic array of events flits across our memories: the skirling bagpipes, haggis, the Gay Gordon, the wood choppers and fire fighters, Windsor Castle, the Rolls Royce factory, Rugby matches, charming hostesses, tartan waistcoats, gin and sherry, Oxford Street, rare old books, cathedrals mellow with age, the beautiful green countryside—the list could go on and on.

How can we ever repay our British friends for a trip that's an epoch in our lives? We saw a little bit of bad in the best of it and a lot of good in the worst of it, and with American verve enjoyed and were impressed by all of it. A toast to our orthopaedic associations and to all of our British friends who were so kind and courteous to a group of intemperate travelers!

CANADA

CANADIAN ORTHOPAEDIC ASSOCIATION—ANNUAL MEETING, 1949

The fifth annual meeting of the Canadian Orthopaedic Association was held at Devil's Gap Lodge, Kenora, Ontario, June 8–12, 1949.

Presentation of a presidential gavel—At the annual dinner of the Association on the evening of June 10, the President, *Dr R. I. Harris*, presented a gavel for the conduct of meetings. Dr Harris said that it had always been his wish that such a gavel should be made of distinctively Canadian material. It had been made from the ivory of a narwhal tusk secured by Eskimo hunters in the Canadian Arctic through the facilities of the Hudson's Bay Company—" The Company of Gentlemen Adventurers Trading into Hudson's Bay—Incorporated 1670." The case was made of Canadian walnut, and the inscription plates were of Canadian silver. The gavel was made from original narwhal tusk by the skilful craftsmanship of Dr C. H. Robson, chief anaesthetist at the Hospital for Sick Children, Toronto, " a man well versed in the peculiarities of orthopaedic surgeons."

Design for Coat of Arms of the Canadian Orthopaedic Association—*Dr Alexander Gibson* presented a design for the Coat of Arms and Seal of the Association for which provision exists in the Act of Incorporation. The design emphasizes the nature of the speciality of orthopaedic surgery and the dual nationality, French and English, from which Canadians stem.

Legg-Perthes' disease—*Dr R. Gordon Townsend* (Calgary, Alberta), reviewing the pathology and treatment of Perthes' disease of the hip joint, referred to the findings of Howorth in fifty patients treated by operation. Among thirty-three patients treated conservatively, and followed up for a period of ten years, only 12 per cent. had a poor result.

Late results in congenital dislocation of the hip—*Dr W. A. Gardiner* (Winnipeg, Manitoba), from the tremendous wealth of his accumulated material, demonstrated many of the problems of congenital dislocation. He emphasized the importance of early diagnosis, and said that although the shelf operation was useful in late cases with slanting acetabular margins, old unreduced dislocations were often best left alone. *Dr Smith-Petersen* (Boston) deprecated osteotomy in these cases because it increased the difficulty of performing mould arthroplasty in later years.

Slipped upper femoral epiphysis—*Dr Alexander Gibson* (Winnipeg, Manitoba) said that the treatment of slipped upper femoral epiphysis by manipulation should be reserved for cases of acute slipping; even then it should be used only with caution. Open operation was indicated in subacute cases when there was moderate or severe slipping. The danger of pseudarthrosis at the site of osteotomy had to be considered.

Gavel constructed from the ivory of a narwhal tusk obtained from Eskimo hunters in the Canadian Arctic, with a case of Canadian walnut and inscription plates of Canadian silver, presented to the Canadian Orthopaedic Association by its President, Dr R. I. Harris.

Mould arthroplasty of the hip joint—*Dr M. H. Smith-Petersen* (Boston, Mass.), guest speaker, reviewed arthroplasty of the hip joint from its early evolution in 1923, and gave a detailed description of approaches to the hip joint and the technique of joint reconstruction. Three important difficulties experienced in former years had now been overcome; poor exposure, poor instruments, and a poor barrier between the articulating surfaces, fascia having been replaced by a vitallium cup. All stages of post-operative care were illustrated. The results of 700 cases, operated on over a period of ten years, were reviewed. The author chose to avoid the term " end-results " because a ten-year follow-up was not long enough to justify the use of this term.

Denervation of the hip joint for hypertrophic arthritis—*Dr J. L. Larochelle* (Quebec) reported observations on the innervation of the hip joint based on dissections of 106 subjects. Nerve filaments came from the obturator nerve and the nerve to the quadratus femoris. In sixteen subjects there were no articular filaments from the nerve to the quadratus femoris; there was an accessory obturator nerve supply in five. Indications for denervation of the joint were: Little's disease, chronic arthritis without deformity of the femoral head, arthritis when extensive surgery was refused, arthritis when the general condition prohibited major surgery, bilateral coxalgia, and " painful adductor sprain." Neurectomy might also be advisable when pain persisted after arthroplasty.

Synovectomy in chronic arthritis of the knee joint—*Dr J. Edouard Samson* (Montreal, Quebec) traced the historical development of synovectomy of the knee. Between 1930 and 1946, one hundred and

ninety-two patients had been operated upon with good results in 40 per cent. Patients with severe flexion contracture, and those with disabling polyarthritis, were not considered suitable. The complications included haemarthrosis, wound infection, severe post-operative joint stiffness and myositis ossificans.

Errors in the diagnosis of internal derangement of the knee joint—*Dr H. H. Boucher* (Vancouver, B.C.) reported one hundred and seventy-five derangements of the knee joint seen at the Shaughnessy Hospital, Vancouver, with an error in diagnosis of 12·5 per cent.; and eighty cases seen in private practice with a 9 per cent. error. The main factor in reducing the percentage error in diagnosis was appreciation of McMurray's diagnostic manoeuvre. Hypermobility of the meniscus was an important cause of derangement. Errors in diagnosis included early tuberculosis of the knee joint and chondromalacia of the patella. There was sometimes error in attributing the lesion to the wrong meniscus; and in others the knee joint was normal.

Diagnosis of difficult vertebral lesions by trephine biopsy—*Dr John C. Kennedy* (London, Ontario) demonstrated the technique of trephine biopsy based upon the use of an instrument devised by Dr Harris. The technique was similar to that used for paravertebral block. Radiographic control and general anaesthesia were used. Six cases were presented with photomicrographs. The method had been used in the diagnosis of many patients treated at the Hospital for Tuberculosis, Weston, Ontario, and at the Toronto General Hospital.

Femoral torsion as a cause of in-toeing and out-toeing—*Dr W. T. Mustard* (Toronto, Ontario) said that abnormality of gait with in-toeing or out-toeing might be due to forefoot adduction or internal tibial torsion, but it was necessary also to look above the level of the knee joint; femoral torsion was a common cause. Delay in rotation of the limb at the upper end of the femur led to torsion and anteversion of the femoral neck so that the limb must be rotated inwards to maintain the head in the acetabulum. In mild cases treatment by holding the limb in external rotation in Denis Browne night splints was satisfactory; but supracondylar rotation osteotomy was sometimes necessary.

Treatment of bone tuberculosis in North American Indians and Eskimos—*Dr J. Olav Rostrup* (Edmonton, Alberta) reviewed the treatment of bone tuberculosis in Indians and Eskimos over a three-year period from 1946–49. Seventy-three patients had been treated; but many others, who were unfit to travel, had probably died without treatment. Most were young; only 5 per cent. were over the age of forty years. Conservative treatment had been used. Streptomycin had been reserved as a lifesaving measure and as an adjunct in treating sinus tracts.

Conservative treatment of brachial neuralgia—*Dr G. H. Ryan* (Winnipeg, Manitoba) discussed brachial neuralgia in a series of patients including 169 men and 199 women. Neuralgia occurred usually in the 50–60 year age-group. The syndrome was characterised by pain in the neck and shoulder radiating to the deltoid insertion or to the base of the occiput. Protrusion of cervical intervertebral discs or hypertrophic arthritis of the intervertebral joints was often responsible. In 303 of the 368 cases, conservative treatment by head traction for a period of ten days to three weeks, with massage and ultraviolet radiation, relieved the symptoms.

Congenital hallux varus—*Dr A. W. Farmer* (Toronto, Ontario) discussed the unusual problem of congenital hallux varus. This might occur alone, with metatarsus varus, or with congenital club-foot. The great toe was sometimes at right-angles to the general axis of the foot, thus making it impossible to fit a shoe. Operative repair consisted of suturing together the great and second toes, using a skin flap from between them to fill in the region over the medial side of the first metatarso-phalangeal joint which was opened to align the phalanx with the metatarsal.

Epidemic of poliomyelitis among Eskimos at Baker Lake—*Dr Duncan Croll* (Winnipeg, Manitoba) reported on his recent visit to Baker Lake in the Canadian Arctic to deal with an extensive epidemic of poliomyelitis. This was the first recorded occurrence of the disease in Eskimos. General interest in his report was enhanced by the excellent series of photographic colour transparencies which depicted the manner of life of the Caribou Eskimos and the environment in which they live.

Syme's amputation—*Dr W. B. McKinnon* (Winnipeg, Manitoba) in reporting twenty-seven Syme's amputations, recalled that the operation had been devised originally for the treatment of tuberculosis of the tarsus or ankle. As indications he would include also certain injuries, vascular defects, foot deformities and infections. Four such amputations had been carried out for neurotrophic abnormalities.

Suction socket prosthesis—*Dr R. C. Rider* (Toronto, Ontario) outlined the history of development of the suction socket. A motion picture demonstrated the fitting and application of the prosthesis and displayed the gait of various patients. The prosthesis was unsuitable for patients with osteomyelitis, for those with deep infolding scars or serious skin eruptions, and for patients with poor psychological attitude. The real advantages were the elimination of a pelvic band and harness, and the excellent gait which was usually acquired.

Intramedullary nailing of fractures—*Dr Antonian Samson* (Montreal, Quebec) reported results from an experimental study of intramedullary fixation of fractures in rabbits, and reviewed seven years' experience of the treatment of fractures by intramedullary fixation in human beings. From this accurate

and detailed study he concluded that intramedullary nailing should always be preceded by open reduction; the nail must be of the correct size; the femur was the ideal bone for this treatment; intramedullary nailing of the clavicle, humerus and tibia should be abandoned.

Traumatic arterial spasm—*Dr Ian W. Davidson* (Sudbury, Ontario) reviewed the problems of traumatic arterial spasm and ischaemia of limbs due to direct or indirect injury to the nervous control of the arterial supply. He classified the clinical types and outlined the treatment of all stages in detail.

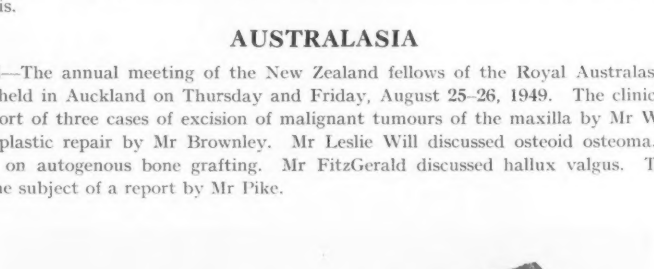
Sympathectomy in the treatment of peripheral vascular disease—*Dr Gordon M. Dale* (Toronto, Ontario) reported one hundred ganglionectomies performed in eighty patients with vascular disease over a twenty-year period. Unusual complications of Buerger's disease included two cases of rupture of the myocardium, two of atrophy of the testicle, and many of mesenteric thrombosis. All these complications occurred in young people. Paravertebral block was not a good indication of the value of sympathectomy. In reviewing the results of treatment, the importance of early operation was stressed.

Fat embolism—*Dr E. S. James* (Winnipeg, Manitoba) presented two cases of fat embolism. Microscopic examination revealed fat in the lungs and kidneys. The first patient presented a classical radiographic picture of fat embolism of the lung; despite early hemiplegia he recovered. The other patient died.

Clinical demonstration at Winnipeg—On the last day, the meeting was transferred to Winnipeg in order to observe demonstrations of the postero-lateral approach to the hip joint practised by *Dr A. Gibson*. At the Department of Veterans' Affairs, Deer Lodge Hospital, the technique was demonstrated in anatomical specimens and also in many patients in whom the approach had been used for arthroplasty of the hip joint in osteoarthritis.

AUSTRALASIA

New Zealand—The annual meeting of the New Zealand fellows of the Royal Australasian College of Surgeons was held in Auckland on Thursday and Friday, August 25–26, 1949. The clinical programme included a report of three cases of excision of malignant tumours of the maxilla by Mr Webster with a discussion on plastic repair by Mr Brownley. Mr Leslie Will discussed osteoid osteoma. Mr Christie gave a report on autogenous bone grafting. Mr FitzGerald discussed hallux valgus. The surgery of tendons was the subject of a report by Mr Pike.



Gavel presented to the Australian Orthopaedic Association by orthopaedic surgeons of the Royal Navy.

Australian Orthopaedic Association—The report in this number of the Journal of the presentation of a gavel to the Canadian Orthopaedic Association by its President, Dr R. I. Harris, reminds us that another gavel was presented to the Australian Orthopaedic Association by the surgeons of the British Navy who were serving in Australia during the recent war. We take the opportunity of reproducing a photograph of this instrument of office which includes on its silver plate the inscription:

A.O.A. 1945

This Presidential Mallet made of Australian woods in the Red Cross Remedial Workshop of the Royal Naval Hospital, Sydney, is presented to the Australian Orthopaedic Association as a very small memento of the Association's kind hospitality to Medical Officers of the Hospital

together with the signatures of H. Jackson Burrows, O. Vaughan-Jackson, James Wishart, R. A. Mogg, D. R. Maitland, J. F. R. Withycombe and H. P. Watson.

GREAT BRITAIN

BRITISH ORTHOPAEDIC ASSOCIATION—ANNUAL MEETING, 1949

The annual meeting of the British Orthopaedic Association was held at Bristol in October 1949, under the presidency of Mr S. A. S. Malkin. Among the many visitors were Dr J. Agerholm-Christensen of Copenhagen, Mr F. P. Fouche of South Africa, and Professor J. Verbrugge of Antwerp. A clinical demonstration at the Winford Orthopaedic Hospital by Mr Pridie, Mr Eyre-Brook and their associates, paid tribute to the inspiration of Hey Groves whose spirit still lives.

DISCUSSION BY FELLOWS OF THE ASSOCIATION ON THE RELATIONSHIP OF ORTHOPAEDIC SURGERY TO TRAUMATIC SURGERY

Mr William Gissane (Birmingham) said that many young surgeons had been admitted to membership of the Association without full training in orthopaedic surgery and solely on their experience of emergency surgery in the treatment of bone and joint injuries. A discussion on the relationship of accident surgery to orthopaedic surgery, and the training of surgeons who would practise traumatic surgery, was urgently needed. In the earlier part of the century, orthopaedic surgeons had laid claim to the surgery of the locomotor system and had specifically included the treatment of accidents; but even now, in the middle of the century, this commitment had not yet been accepted fully. Many patients were still referred to orthopaedic departments after long delay in hospital casualty departments, so that orthopaedics remained only the second line of treatment and gained little opportunity of advancing the early treatment of open wounds, burns and hand injuries. The same point had been reached in the development of plastic surgery; again there was the first barrier of a casualty department which was not always staffed sufficiently and often caused unfortunate delay. It was now to be considered how to make a practical reality of the best possible treatment of injuries at the acute stage. Quite surely this was not to be achieved by the development of yet another speciality, segregated and confined within the limits of the term "accident surgeon."

No less than 80 per cent. of patients were admitted to casualty departments by reason of accident. In 10 per cent. there were infections of the skin and subcutaneous tissues, and only 10 per cent. called for reference to the medical or general surgical departments. In a single year, one and a quarter million accident cases were treated in the casualty departments of 1,318 hospitals in this country and the vast majority were injuries to the locomotor system. Of injuries to the head, chest and abdomen, less than half called for surgical intervention. It could be claimed justly that control of the casualty departments of these hospitals was part of the commitment of orthopaedic surgeons.

The establishment of fracture clinics, as recommended by the Delevigne Committee, did not comprehend the problem. The treatment of fractures was but a small part of the work of accident services. The Birmingham experiment, with facility for the reception, immediate treatment and after-care of patients with every form of injury, had proved successful. A comprehensive service for a population of approximately two million people could be developed on these lines. Simple accidents might still be treated in the casualty departments of their local hospitals; but when the injury was of a specialised nature, or when it was serious, the patient should be transferred at once to the central accident hospital where, on both economic and clinical grounds, it was reasonable to create full facilities and have the essential skilled staff available every hour of the day and night. After-care and out-patient treatment could still be undertaken at the peripheral hospital nearest to the patient's home.

The accident unit must not become segregated; it should develop a relationship with surgery as a whole, and maintain an association with orthopaedic and plastic surgery. To cover the treatment of accidents in this country, approximately twenty units similar to the Birmingham Accident Hospital would be needed; but every such unit should be attached to the general hospital of a teaching school.

The traumatic service should be controlled by orthopaedic surgeons. In the Birmingham Accident Hospital, surgeons with orthopaedic training had proved much more successful than those with general surgical training alone. Orthopaedic training gave familiarity with the surgery of the locomotor system and the essential preliminary planning and after-care that was necessary. At the same time there was need for acceleration in speed of thinking and decision when orthopaedic surgeons were faced with the problems of acute injury. Moreover, it was absolutely essential to plan additional training in the technique of plastic surgery.

There had been neglect in the instruction of young graduate house officers in such fundamentals as the care of the open wound, the after-care of diseases and injuries of the locomotor system and the planning of treatment with a sense of time and cost in relation to the work of the patient. After preliminary training in general surgery, and full training in orthopaedic surgery, surgeons who proposed to specialise in accident surgery should learn at least the first principles of plastic surgery, and thereafter gain practical experience of the work of a special unit such as that in Birmingham. There might one day be a degree in orthopaedic surgery which would include a knowledge of accident surgery no less real than that now accepted in the surgery of congenital and established deformities.

Mr E. A. Nicoll (Mansfield) said that traumatology was now practised in Great Britain in three ways in conjunction with orthopaedics; as a part of general surgery; and as a specialty in its own right. It was to be considered whether traumatology had yet earned the right to be regarded as a specialty. Certainly there was much more than the treatment of fractures; injuries to every part of the body were included and there was in this field of surgery a wider repertoire of technique than in most special branches. But there were two difficulties in accepting traumatology as a specialty. It dealt with acute conditions, which limited the geographical area to be served effectively by any one team; only in a few large and densely populated industrial areas would it be possible to collect the variety of material necessary to keep a first class unit at full stretch. Moreover, if all accident cases in a given area were to be dealt with by a traumatic specialist, cold orthopaedics would become self-contained—which would be unfortunate. Traumatology should be practised as a specialty only in exceptional circumstances. Even then the traumatic specialist must always have been experienced in orthopaedic surgery. For the most part it was undoubted that traumatology should be combined with the ordinary practice of orthopaedics, the orthopaedic surgeon first being trained in certain additional techniques and taught the art of quick decision. The real solution lay in a better distribution of orthopaedic surgeons throughout the country. Only when this had been achieved could traumatology be separated from the practice of general surgery and from that of general practitioners " with a flair."

Mr H. Osmond-Clarke (London) asked three questions. Where was the accident service to be located? Who was to treat the accident cases? What should be the training of the accident surgeon? Accident hospitals had achieved success, but the accident unit should usually be sited in a general hospital. Close contact with teaching hospitals must be achieved. Whether or not the surgeon confined himself to the treatment of traumatic cases he must have had preliminary training and experience in orthopaedic surgery. It was true, as Mr Nicoll had pointed out, that reliance must sometimes be placed on general surgeons but in these cases the patient should be transferred as soon as possible to the nearest well-organised accident unit. Both Mr Gissane and Mr Nicoll had agreed that the training of accident surgeons should include general surgery, general orthopaedic surgery, and the special techniques required in the treatment of shock, burns and the replacement of skin loss. He visualised that orthopaedics might become divided into separate specialties for the treatment of arthritis, congenital deformities, injuries, and other groups of cases; but wondered whether the practice of any one subdivision such as accident surgery would be enough to satisfy a man who was trained fully in orthopaedics.

Mr Rainsford Mowlem (London) said that the Association must consider whether the orthopaedic surgeon was in fact the best man to be a traumatic surgeon. The integrity of skin was of prime importance in the treatment of all locomotor tissue injuries. Skin restoration must often precede orthopaedic measures. He hoped that there would always be full co-operation in any traumatic unit between the plastic surgeon and the orthopaedic surgeon.

Mr Philip Wiles (London) asked how the training of an orthopaedic surgeon was to be determined. Specialists in general surgery were labelled by the possession of a Fellowship. In orthopaedic surgery there was usually no special examination or degree. Should there be a more organised system of training with a University degree in orthopaedics?

Mr R. H. Metcalfe (Purley) said that traumatic surgery had gained great emphasis since the last war, but the training of young orthopaedic surgeons had presented some difficulties. In one Metropolitan region a special scheme had made it possible for registrars to gain experience in several different orthopaedic units. In each area, six orthopaedic registrars had alternated appointments in the casualty departments of main hospitals, in the wards and consultative out-patient departments of general hospitals, and in the long-stay orthopaedic hospitals. Such wide experience was invaluable; but the problems of organisation were not simple.

Mr Bryan McFarland (Liverpool) said that it would be most unfortunate to set up an " Institute of Traumatology " as a separate branch of surgery. The accident unit should be within a general hospital with an orthopaedic surgeon in charge. Those training in orthopaedic surgery should gain experience in trauma as part of their training. The plastic surgeon should co-operate both in the treatment of injuries and in the training of orthopaedic specialists. The planning of a University degree in orthopaedic surgery was complicated, but the difficulties could be met if teaching was more closely organised and if the degree was awarded only after a period of approved experience.

Mr H. A. Brittain (Norwich) advocated the establishment of a certifying board by the British Orthopaedic Association on the lines of the American Board of Orthopaedic Studies.

Mr N. Birkett (Nottingham) considered that special accident hospitals were impracticable in many places. Practical experience of orthopaedics over a long period was far more important than the issue of a certificate.

Miss M. Forrester-Brown (Bath) drew attention to the difficulties of transport in many areas where the population was dispersed and referred to the Ontario scheme by which radiographs of patients who had sustained fractures were sent over long distances to orthopaedic experts who then advised as to whether the position of the fracture should be accepted or whether further reduction was necessary.

The President, while admitting the difficulties of transport, hoped sincerely that these would not be met in the manner described by Miss Forrester-Brown as the " Ontario scheme."

Mr Norman Capener (Exeter) referred to the special problem of the wide dispersal of accident cases in agricultural districts. Accident centres were very necessary but there had to be many of them. They must always be in general hospitals of varying size. The training of individuals for orthopaedic surgery and for traumatic surgery should be undertaken in general hospitals.

Mr M. Langston (Southampton) asked for an immediate and practical policy. Large accident units for the treatment of patients and for the training of specialists were not yet in general existence. It seemed to him that the area scheme by which registrars alternated between various types of unit, as outlined by Mr Metcalfe, was excellent.

Mr Norman Roberts (Liverpool) believed that the accident hospital as described by Gissane, was not the right answer. The accident unit should be sited in the general hospital. Furthermore, the casualty department of a general hospital should be under the control of the accident service and directed by the orthopaedic surgeon.

Mr J. Scott (Oxford) supported Mr Roberts' view that accident work should be retained in general hospitals and not be directed to special accident hospitals. In referring to the question as to whether or not there should be " traumatic specialists," he said that the crux of the matter was whether or not orthopaedic surgery was yet too large a subject. Theoretically it might be; but in practice it was not. There were several possible sub-divisions of orthopaedic surgery but as to how it should be divided was not yet clear. The necessity for comprehensive preliminary training in all sub-divisions of surgery was undoubted and it could not be denied that many traumatic surgeons were inadequately trained in orthopaedics.

Mr E. N. Wardle (Liverpool) deplored the tendency to appoint the most junior member of a general hospital staff to the accident or casualty department.

Mr Roland Barnes (Glasgow) said that the formation of special accident hospitals would present very great difficulties in the training of undergraduates. Every teaching hospital should have within its precincts an accident unit under the control of the orthopaedic department.

Professor George Perkins (London) said that the discussion had been planned on broad lines. It was necessary to determine the attitude of the British Orthopaedic Association to traumatology. In summarising the discussion he suggested that three resolutions might be agreed, namely: 1) every man practising orthopaedic or traumatic surgery must be properly trained; 2) the Association must not be divided; 3) traumatology must not be encouraged as a specialty.

The President in closing the discussion welcomed the clarifying views of Professor Perkins and endorsed his three points. Mr Nicoll had made an admirable summary of the existing situation and the Association could not fail to agree. Practical experience was of much greater importance than the possession of a special degree. The emphasis must be on training in general orthopaedic surgery and thereafter special training in the principles of plastic surgery and specialisation in traumatology.

LESIONS OF THE LUMBAR INTERVERTEBRAL DISCS

Mr J. Pennybacker (Oxford), basing his remarks on 800 cases, most of them with root pain, referred to the importance of differentiating neoplasms such as neurofibroma, ependymoma, meningioma and intramedullary tumour of the conus. In such cases the patient might ascribe the onset of symptoms to a strain of the back, and the symptoms might be intermittent; but the neurological signs of muscle wasting, altered cutaneous sensation, or abnormal reflexes, were usually progressive. Radiographs often showed no change but they might reveal scalloping of the posterior surfaces of the vertebral bodies or increase of width between the pedicles. Lumbar puncture usually revealed increase in the protein content of the cerebrospinal fluid and myelography established the diagnosis. Tumours had been present in less than 5 per cent. of his series. Other conditions to be differentiated included tuberculous disease of the lumbar spine or sacro-iliac joint, metastatic carcinoma and spondylolisthesis. In twenty-seven cases (rather more than 3 per cent.) no lesion had been found. Two signs were particularly useful: Nafsigger's sign in which, with the patient upright, jugular compression caused paraesthesiae of root distribution, ceasing when pressure was released—a sign which was positive in any root lesion; and secondly, sudden pressure over the lumbar spine of the prone patient which might cause local pain and reference to the sciatic distribution. Treatment by bed rest, a plaster jacket for six weeks, and thereafter a corset, was advised. Operation was reserved for cases that did not respond to such treatment and for those with frequent recurrence. Manipulation was not favoured because it had caused almost complete lesions of the cauda equina which recovered slowly and might leave permanent loss of sphincter control. Exploration should be extensive and include the fourth and fifth lumbar and first sacral roots. The spinous processes and lower margins of the laminae of the corresponding vertebrae were removed. Both sides were explored and the theca was opened. Multiple lesions were unusual. Arthrodesis was usually performed only at a secondary operation when relief was incomplete. Occasionally, in the second or third weeks of convalescence the patient suffered agonising spasms of pain in the back, precipitated by movement and without sciatic

irradiation; and in such cases the radiographs showed fuzziness of the adjacent vertebral bodies and subsequently a good deal of new bone formation. Treatment of this complication in the acute stage was by immobilisation in a plaster bed for four or five weeks. Such cases did well, and he doubted whether they were due to infection.

Mr E. N. Wardle (Liverpool) said that it was a mistake to concentrate attention upon one disc when there was loss of equilibrium of the whole lumbar spine with loss of elastic reaction of many discs. In such a state, retropulsion and sciatica were no more than incidental. The orthopaedic principles of correction and fixation were met by the application of a plaster jacket in head suspension. Of 269 patients treated between 1937 and 1949, 60 per cent. had gained complete relief. Relapse might occur and in these patients with permanent loss of elasticity of a disc, operation might be necessary; but it should still be treated after operation by fixation, external or internal.

Mr J. R. Armstrong (London) dealt chiefly with the causes of operative failure. In the first place there might be failure to find the lesion, sometimes because there was none, but more often because of exposure at the wrong level or limited exposure at the correct level. Mid-line protrusions were hard to find, and "concealed disc lesions" were far more common than had been acknowledged. Other causes of failure were: failure to recognise a double lesion which occurred in about 20 per cent. of cases; failure to deal with a bilateral lesion which needed exposure on both sides; insufficient removal of the disc which gave rise to further protrusion; operative damage to the nerve root; post-operative adhesion of the nerve root to the scar and especially to the remnants of nuclear material; subsequent prolapse of a previously healthy disc; permanent changes in the root from prolonged compression; and arthritis of the intervertebral joints. There were several reasons for not performing arthrodesis at the time of operation: it was usually unnecessary; the complications and dangers were greater; a longer period of post-operative immobilisation was required; arthrodesis, if necessary, could be done more conveniently later; and it was difficult to do a second root operation after arthrodesis if the first operation had failed.

Mr R. H. Young (London) discussed the result of operation in 832 cases in which it was considered that a pathological disc had been demonstrated. He excluded an unstated number of cases in which no pathology was found, or in which the pathology had no relation to the disc. Whereas formerly he operated on about one-third of all the cases he saw, he said that he now operated on about one in fifty. Nevertheless, we understood from him that he performed 180 of these operations last year which would suggest, unless we misinterpret him, that he sees some nine thousand cases of lumbar intervertebral disc injury each year.

Mr William J. Virgin (Liverpool), in a paper read by Mr B. L. McFarland, recorded studies of deformation of vertebral discs under load, and recovery on release. The elastic properties of the immature disc in childhood were less than in the adult. Performance improved with successive loadings. Incision of the annulus into the nucleus interfered little with the properties of the disc, which did not appear to depend upon an intact nucleus but upon the fluid content, the disc losing water during compression and taking it up during recovery. Elasticity diminished in wasting diseases and with local vertebral change.

Mr G. L. Alexander (Bristol) discussed the coincidence of lumbar disc protrusion with spondylolisthesis. A case of listhesis of the fourth lumbar vertebra on the fifth was associated with lumbo-sacral disc lesion with symptoms referable to the first sacral root. In seven cases of spondylolisthesis he had observed three with disc lesions at the corresponding or another level.

Mr E. A. Nicoll (Mansfield) said that myelography with the newer radio-opaque fluids was safe, and was useful in determining the nature of the lesion and its level. It might reveal a second lesion and gave accurate conclusions.

Dr E. J. Crisp (London) described the ruptured disc as a universal lesion having no age limit. He usually saw cases early and applied a plaster jacket without correction of deformity, which usually disappeared after a few weeks. The plaster was changed at intervals but fixation was continued for ten or twelve weeks. About 80 per cent. of patients were relieved.

Mr Sayle Creer (Manchester) advocated early operation; *Mr Newman* (London) emphasized the dangers of flexion movement in manipulation; *Mr Le Vay* (London) having operated on 130 patients was evidently less pressed than Mr Young, this representing only 10 per cent. of his series; and *Mr K. H. Pridie* (Bristol) ascribed the low back tribulations of the twentieth century to the failure in modern times to observe one day's rest in seven.

Protrusion of cervical discs—*Mr G. L. Alexander* (Bristol) recalled that symptoms might be due to compression of a nerve root or compression of the spinal cord, and occasionally to both. In the syndrome of nerve root compression, aching in the neck was often the first symptom and might be initiated by strain. Sensory manifestations were much more pronounced than motor changes but sometimes there was loss of power in the fingers. The hyperaesthesia occasionally found over the upper part of the shoulder and trunk was perhaps due to intersegmental spread or vascular phenomena. Muscle fasciculation sometimes occurred and tendon reflexes might be modified. It had been suggested that the almost invariable affection of the roots of C.6 and 7 was due to proximity to a fixed part of the spine; but he preferred to ascribe the distribution to the thickness of the roots of C.6, 7 and 8, the last root usually escaping because it

course was less oblique, and it was subjected to less traction by movements of the neck and shoulder. When operation was needed, decompression was carried out with a dental drill. The syndrome of cord compression could occur from a ruptured disc anywhere from the second to the seventh cervical vertebrae. The higher ones might give bizarre sensory disturbances, confused distribution of muscle weakness and anomalous changes in the reflexes. The cervical vertebral canal was roomy, so that compression of the cord was possible without change in the cerebrospinal fluid and lumbar puncture seldom helped. Disproportionate vascular disturbance sometimes produced a neurological picture suggesting an intramedullary lesion. Myelography with pantopaque or myodil was helpful. Cord compression called for laminectomy and removal of the displaced material. In both root and cord syndromes, the results of operation were good but they were not perfect. *Mr Roland Barnes* (Glasgow) spoke of paraplegia in injuries of the cervical spine without bone displacement. In such cases the Queckenstedt test was unreliable. If myelography showed a disc lesion, laminectomy should be performed.

Lambotte and the early period of bone suture—*Professor J. Verbrugge* (Antwerp) painted a vivid and charming picture of Monsieur Lambotte, an early pioneer of bone suture who, unlike his English counterpart, Sir Arbuthnot Lane, was still living at the age of eighty-five. He still did two or three operations a month with a steady hand. A kindly, witty, highly cultured *bon-viveur*, he was remarkably versatile and highly skilled. Among his hobbies were violin making and clock repairing.

Fractures of the upper end of the radius in children—*Mr C. C. Jeffrey* (Birmingham) had studied eighty fractures of the upper end of the radius in children and adolescents under the age of eighteen years, treated during a six-year period at the Birmingham Accident Hospital. He limited his remarks to twenty-four cases of fracture through the neck of the radius or separation of the upper epiphysis. The cause of displacement was usually axial compression with abduction, as shown by frequent association with avulsion of the medial epicondyle, rupture of the medial ligament, or abduction fracture of the ulna. The position of the forearm at the time of injury, as to pronation or supination, determined the direction of tilt of the radial head. This was estimated before reduction by radiography in various positions. With the forearm suitably rotated, closed reduction was carried out by digital pressure on the radial head with the elbow adducted. Open operation was reserved for cases in which this manoeuvre failed or in which the head was completely displaced. In young children with twenty degrees of tilt or less, no reduction was performed. Two cases in which the epiphysis was rotated through ninety degrees were believed to be due to momentary posterior dislocation with a blow on the back of the diaphysis in falling, so that the epiphysis was displaced behind the humerus and left there at the recoil; the displacement was reduced by operation. When there was tilting without separation, late review at intervals up to six years showed that the results of manipulation and of operation were about the same: there was no deformity; some had slight restriction of movement and sometimes there was premature fusion of the epiphysis; imperfections of reduction tended to disappear with growth. When there had been complete separation there was more often premature fusion, deformity of the head and limitation of movement. *Mr R. C. Murray* (Inverness) believed that even if closed reduction failed, open operation was seldom needed unless there was great displacement. Correction of the position took place as growth occurred. *Mr V. H. Ellis* (London) considered that limitation of rotation might be caused by subluxation of the lower radio-ulnar joint from disproportionate growth of the forearm bones after premature fusion of the upper radial epiphysis. After manual reduction of a greenstick fracture of the neck of the radius, the position could not be maintained, because reduction of a greenstick fracture was unstable unless the fracture was completed. In this situation, this was not possible. *Mr J. C. Scott* (Oxford) agreed that tilting in young children needed no reduction. [*Editor's note*—There is most certainly no general agreement with some of these observations. Uncorrected tilting of the head of the radius in children, even of lesser degree, may cause not only limitation of radio-ulnar movement but limitation of extension of the elbow which does not change with growth however much the tilt may become masked in radiographs. When closed manipulation fails, manipulation through a short incision is very easy—and despite theories about greenstick fractures it is always maintained.]

Experimental rupture of the medial ligament of the knee joint—*Mr E. A. Jack* (Edinburgh) had studied the changes after manual rupture of the medial collateral ligament by forced abduction of the knee in cats, in which he had found the liagment to present a similar anatomical and vascular pattern to that of man. Rupture occurred at the upper end in seven, at or near the lower end in six, and as an oblique involvement of most of the length of the ligament in six. Capsule and synovial membrane were involved in tears of the upper end and sometimes at other levels. Ligamentous recoil was invariable, with a gap which could no longer be closed after seven to ten days. Healing occurred except in most cases of rupture at the upper end where failure might be due to the width of gap, ischaemia, or leakage of synovial fluid. Animal experiments suggested that the best treatment of this ligament rupture was operative repair during the first week, with the least possible interference with blood supply.

Hallux rigidus—*Mr A. C. Bingold* (Leeds) reported a radiographic and morbid anatomical study of hallux rigidus. The dense and sometimes bipartite epiphysis for the base of the hallux, which had been said to be a manifestation of osteochondritis juvenilis and a cause of hallux rigidus, was no more than a normal phase of development from about the age of six years to adolescence. The bony trabeculae threw a dense shadow in radiographs because they were at right angles to the axis of the digit. Early hallux rigidus was characterised by synovial hyperaemic reaction, effusion without evidence of infection, and slight erosion of the articular cartilage of the phalanx but not of the metatarsal. The anatomical changes of the osteoarthritis that developed were greater than radiographs would suggest. *Mr Norman Roberts* (Liverpool) observed that the child with hallux rigidus often had stiffness of the corresponding thumb joint; but *Mr K. I. Nissen* (London) referred to Harris and Joseph's observation that stiffness of this joint of the thumb was related to developmental flattening of the first metacarpal head; and *Mr E. A. Jack* (Edinburgh) had found that the stiffness of hallux rigidus in childhood disappeared under anaesthesia, indicating that it was due to spasm.

Osteotomy of the spine—*Mr W. A. Law* (London) showed a film of the operation and the dramatic results of osteotomy of the spine for deformity in ankylosing spondylitis. The object was to produce a compensatory lumbar lordosis by making a gap in the neural arch and angulating the spine at this level by osteoclasis. Not only was bone removed from the laminae and articular processes but the margins were so shaped that the fragments interlocked safely when the spine was extended. Plaster of Paris was then applied to the trunk and thigh. The operation had been performed successfully in seventeen cases.

Experiences in Mauritius—*Mr J. M. Fitton* (Floreal Hospital, Mauritius) after a brief reference to the geography, climate, economy and races of Mauritius, described the orthopaedic service that had been developed since 1945 when the island was stricken with an epidemic of poliomyelitis. *Mr H. J. Seddon* (London) referred to the difficulty and magnitude of the task which Mr Fitton had so modestly described, and the fact that this individual work had often to take second place to more pressing communal medical needs. Colonial orthopaedic centres had now been established also in Malta, Nairobi and Lagos. It was imperative that the men who undertook this pioneer work should have the prospect of suitable places when they returned home.

Radiology and histopathology of malignant bone tumours—*Dr A. L. Taylor* and *Dr P. N. Beamish* (Bristol) summarised the records of the Bone Tumour Registry at Bristol Royal Infirmary. Seventy-two primary tumours of bone had been recorded. They were classified as: 1) related to bone tissue, osteogenic sarcoma, chondrosarcoma, fibrosarcoma; 2) arising within the marrow cavity, Ewings' tumour, reticulosarcoma, multiple myeloma. *Dr R. C. Tudway* (Bristol) pleaded for the treatment of osteogenic sarcoma by deep X-ray alone. He gave three uses for deep X-ray treatment of bone tumours: pre-operatively in all cases for amputation; as the only treatment in specially selected cases, especially in the upper limb; and as a palliative dose in inoperable cases. *Dr S. Curwen* (London) gave the indications for deep X-ray treatment of osteoclastoma and gave the results of recent cases. *Mr Roland Barnes* (Glasgow) favoured biopsy in all doubtful cases and considered it a safe procedure. *Mr H. E. Harding* (London) agreed with the value and safety of biopsy, and showed slides of cases of diagnostic difficulty. He stressed the four main objects of treatment: relief of pain; relief of anxiety; keeping the patient ambulant; saving life. *Mr K. I. Nissen* (London) stressed the importance of age in the diagnosis of Ewings' tumour which seldom occurred after the age of seventeen years, and osteoclastoma which was unusual before the age of twenty years.

Posterior scapulo-humeral arthrodesis—*Mr H. A. Brittain* (Norwich) demonstrated this operation and gave the results in thirty patients, nineteen operated on by himself, ten by Professor Mercer, and one by Mr Nisbet. In twenty-four of these cases there was bony fusion.

Pregnancy and skeletal tuberculosis—*Mr M. C. Wilkinson* (Black Notley) described the effects of pregnancy in thirty-two patients with skeletal tuberculosis. He concluded that none had been harmed by pregnancy and that some had shown an increased rate of healing. *Mr F. G. St Clair Strange* (Canterbury) said that in no case of twenty-seven pregnancies in patients with sacro-iliac tuberculosis was there any sign of reactivation. He did not hesitate to let the patient go to full term.

Arthroplasty of the hip joint—*Mr Charles Gray* (London) showed an excellent film to demonstrate cup-arthroplasty of the hip performed through a lateral approach with removal of the great trochanter. *Mr K. H. Pridie* (Bristol) favoured an antero-lateral approach to the joint.

Election of Fellows and Members—At the business meeting of the Association, elections to fellowship and membership were made:—

Corresponding Member—R. Merle d'Aubigné, Paris.

Fellows—H. E. Harding, London; P. B. Moroney, Liverpool; S. M. Thompson, Grimsby.

Associate Members—H. G. A. Almond, Liverpool; J. E. Buck, London; L. M. Crooks, Royal Air Force; J. K. Elliott, Wellington, N.Z.; N. G. C. Hendry, Aberdeen; S. A. Jenkins, London; T. L. Lawson, Nigeria; M. L. Mason, London; N. H. Morgan, Derby; R. H. Simpson, Northampton.

SCOTLAND

CONTRIBUTION OF EDINBURGH TO ORTHOPAEDIC SURGERY

Inaugural Lecture, George Harrison Law Chair of Orthopaedic Surgery, University of Edinburgh—*Professor Walter Mercer*, in his inaugural lecture, discussed "The Contribution of Edinburgh to Orthopaedic Surgery"* and traced the development of treatment of the sick and injured from the eighteenth century. He recalled the work of great men of the past whose labours had laid the foundations of orthopaedic surgery. The seventeenth and early eighteenth centuries had seen violence and mob rule in Scotland but with the last of the Stuarts law and order had been asserted and under more settled conditions orthopaedic surgery was born.

In 1720 Alexander Monro was appointed Professor of Anatomy in Edinburgh and his brilliant teaching attracted many students from England. He was one of the founders of the Royal Infirmary of Edinburgh where the medical school quickly gained a European reputation. He made Edinburgh's first notable contribution to orthopaedic surgery by his description of loose bodies in the knee joint and their origin from the cartilage of the articular surfaces. His *Anatomy of the Human Bones* went through eight editions in his lifetime. Robert Whytt, colleague of Monro and brilliant physiologist, who was appointed Professor of the Theory of Medicine in 1747, first localised the seat of reflex action in the spinal cord and showed that it was independent of the brain.

About the time of the Battle of Dettingen in 1743, Sir John Pringle, who was regarded as the founder of modern military surgery, made the historic suggestion that military hospitals of opposing armies should be regarded as neutral and immune from attack, a suggestion that was accepted by both sides and led eventually to the formation of the Red Cross Society. Pringle was a pioneer of antisepsis. In his paper entitled "Experiments upon Septic and Antiseptic Substances" the word *antiseptic* was used for the first time in history.

The next important name was that of Benjamin Bell, a medical student in 1766, who was a pioneer of physiotherapy and achieved regional anaesthesia by compression of the nerves supplying the part to be operated upon. At about the same time John Bell (1765–1820) made valuable contributions in the field of surgical anatomy and advised approximation of wound surfaces closely and evenly in contact, so that they might adhere to each other, a method that was contrary to the usual practice at the time. James Russell (1755–1836), the first incumbent of the Chair of Surgery in Edinburgh, gave a detailed description of osteomyelitis, a disease which was imperfectly understood. Sir Charles Bell (1774–1842), who began his study of the nerves in Edinburgh before taking up practice in London, was the first to show that there were two kinds of nerves, sensory and motor; and his name is famous for his account of paralysis of the seventh cranial nerve and the long thoracic nerve. Later, he returned to Edinburgh as Professor of Surgery.

At this time, in the first half of the nineteenth century, the surgical school of Edinburgh was at the height of its fame. Two figures stood out above all others—Liston and Syme; and orthopaedic surgery owed a debt to both. While in Edinburgh, Robert Liston was a successful teacher of anatomy; Syme was his demonstrator. One of his earliest contributions to orthopaedic literature was on "Fractured Neck of the Femur." Although Liston's long splint was seldom used to-day it was he who first emphasized the necessity for efficient immobilisation of the fragments. Among other contributions were the flap method of amputation, the club-foot shoe, devices for reducing dislocations, bone forceps, and an ingenious apparatus for the treatment of ruptures of the tendo Achillis. His description of this tendon injury was graphic: "It is an accident that most frequently occurs to those who have been for a time unaccustomed to violent action of the muscles. It happens to gentlemen of mature years, who, forgetting these, join in the sports of youth, attempting to skip and dance as they were wont to do; suddenly they suppose that someone has inflicted a blow on the leg from behind—their dancing is arrested, the foot cannot be extended, and the nature of the case is forthwith apparent to the most careless observer." The painting of Liston now in University College, London, shows him performing the first operation under ether in Britain.

James Syme, born in 1799, having been denied an appointment at the Royal Infirmary established his own private hospital in Edinburgh. His important contributions were on excision and amputation and the impressive plea that he made for excision of diseased joints as an alternative to amputation was a lasting contribution to conservative surgery. Syme's amputation of the foot, a subject of recurrent controversy, is still advised in Edinburgh as well as in Canada and the United States. Syme was the first in his country to perform subcutaneous tenotomy for torticollis, and excision of the clavicle for sarcoma.

Another great name was John Goodsir, an anatomist of distinction who did valuable work on the formation of bone. In 1843 he claimed that bone was deposited and absorbed by living cells and not directly by the arteries and lymphatics themselves, as had been described. He made important observations on articular cartilage. It was about this time that Hugh Owen Thomas, "the father of

* *Published in full in the Edinburgh Medical Journal* (1949) **56**, 173.

modern orthopaedic surgery," came to Edinburgh from Wales to study for his diploma. He stayed for two years and was described as " an honourable and industrious student of an enquiring mind and with a desire to know the truth."

Coming to more recent times, Professor Mercer mentioned the work of Thomas Annandale, whom he met personally as a first-year student. Annandale succeeded to the chair of clinical surgery in 1877. He made history by his operations on the knee joint, reporting the removal of cartilaginous loose bodies by direct incision in 1879, and being the first to describe a deliberate and planned operation for the relief of internal derangement of the knee joint due to displacement of a cartilage. Finally, said Professor Mercer, Edinburgh must take some credit for the greatest surgeon, Lister, who spent one-third of his active career in that University. It was in Edinburgh that Lister began the investigations that led to his antiseptic theory.

SOUTH-WEST ORTHOPAEDIC CLUB

The autumn meeting of the South-West Orthopaedic Club held at the Bath and Wessex Hospital, Bath, on September 10, 1949. The chairman, Dr Kohn, was introduced by Miss Forrester-Brown. Clinical cases were shown and the problems of treatment of slipped upper femoral epiphysis were illustrated. Miss Forrester-Brown emphasized that a successful functional result lasting ten years or more was often gained in severe unreduced cases by conservative treatment with simple extension and internal rotation exercises. The treatment of talipes equino-varus was shown in all its stages. Mr Bastow pointed out that in unilateral cases the opposite foot often showed a calcaneo-valgus deformity.

Several successful cases of arthroplasty of the metacarpo-phalangeal joints of the hands were presented. The heads of the metacarpal bones were excised as in the Mayo operation for hallux valgus. Patients with ankylosing spondylitis and involvement of the hip joints were shown after excision of the head and neck of the femur on one side. They were able to walk with the aid of a stick and without splintage. Mr A. Burton described a method of arthrodesis of the knee in rheumatoid arthritis. Multiple drill-holes were made across the joint which was then immobilised by an obliquely placed trifin nail. Other cases included excision of the semilunar bone for Kienböck's disease: the criterion for excision was that there were no osteoarthritic changes in pre-operative radiographs.

REHABILITATION AND RESETTLEMENT OF THE DISABLED

British Council Course for Foreign Visitors—A course of instruction in Rehabilitation and Resettlement of the Disabled arranged by the British Council with the Ministry of Health and the Ministry of Labour was attended in October 1949 by twenty-five doctors from thirteen European countries. In addition to a series of lectures on rehabilitation and allied subjects the course included visits to many industrial centres in London and the provinces, where the visitors were able to see at first hand the problems that have to be met and the methods used.

FRANCE

FRENCH SOCIETY OF ORTHOPAEDIC SURGERY AND TRAUMATOLOGY

The twenty-fourth meeting of the French Society of Orthopaedic Surgery and Traumatology was held in Paris on October 7–8, 1949, under the presidency of Professor Guilleminet. Among the subjects discussed were non-tuberculous affections of the sacro-iliac joints, cervico-brachial neuritis, and the use of a bone bank. The procedure adopted for discussions at the meeting was interesting in that the two principal speakers did not open the discussion but concluded it.

During the week, visits were arranged to many surgical clinics. Much interest was shown in the use of an acrylic prosthesis for replacement of the diseased femoral head in chronic hip lesions. At the Hospital for Sick Children a hip operation was shown to a large gathering with the aid of television. Five fellows of the British Orthopaedic Association attended the meeting.

VENEZUELA

VENEZUELAN SOCIETY OF ORTHOPAEDIC AND TRAUMATIC SURGERY

In Caracas, Venezuela, a new Society of Orthopaedic and Traumatic Surgery has been established under the chairmanship of Dr Andres Gutierres Solis. The purpose of the Society is to advance the knowledge of orthopaedic surgery in Venezuela and to establish scientific relations with Great Britain and with all countries that have similar organisations. The officers include Dr A. Pietri Hijo (vice-chairman), Dr Jorge Figarella (executive secretary), Dr Juan G. Yanez (treasurer), and Drs Armando Parada and José Antonion Villegas (assistant members). We welcome this development and look forward to many fruitful associations in future years.

CORRESPONDENCE

GIANT-CELL TUMOR OF BONE

FROM DR LOUIS LICHTENSTEIN, M.D., LOS ANGELES, CALIFORNIA

To the Editor,

Journal of Bone and Joint Surgery.

DEAR SIR,

In the May 1949 issue of the Journal (British volume, 31-B, pp. 236–290) there appeared a series of articles dealing with the pathology, diagnosis, and treatment of giant-cell tumor of bone, or osteoclastoma as the British prefer to call it. In one or another of these articles, the validity of certain views expressed by Drs Jaffe, Portis and myself (1940) is questioned. It is important that the issues be clearly joined so that your readers may be enabled to arrive at some independent judgment, and I wonder therefore whether I may be accorded the privilege of clarifying some of the problems raised through the publication of this letter.

In so far as basic pathologic interpretation is concerned, we are in essential accord with Professor Willis. There appears to be substantial agreement that giant-cell tumor of bone represents a genuine neoplasm of non-osteoblastic connective tissue derivation, and that, while many tumors are successfully treated by thorough curettement (or irradiation), some are undoubtedly aggressive and prone to recur, and occasional ones behave like frank sarcomas either when initially observed or more often, after one or more local recurrences. Willis holds further that histogenetically, the connective tissue composing the tumor is committed to the formation of osteoclasts and with this the writer has no particular quarrel, although he is reluctant to subscribe to the idea that fully differentiated osteoclasts and osteoblasts are " readily interconvertible." In regard to giant-celled tumors, so-called, of synovial or tenosynovial tissues, we agree entirely with Willis that such lesions are wholly unrelated to giant-cell tumor of bone and, indeed, go further in maintaining that they represent peculiar granulomas rather than true neoplasms. The condition has been described as such by Jaffe, Sutro and the writer (1941) under the head of pigmented villonodular synovitis, bursitis and tenosynovitis.

In the matter of specific details, however, there is significant difference of opinion. Thus, it is the writer's impression that Willis is not as critical as he might be in accepting as genuine giant-cell tumors, lesions that develop in young patients below the age of twenty years or that arise in the metaphysis rather than at the end of a long bone. In our experience, such lesions, in the great majority of instances, prove on close histologic scrutiny to be instances of other conditions, on the whole less serious than giant-cell tumor (non-osteogenic fibroma, benign chondroblastoma, bone cyst, etc.). In regard to the lesion of benign chondroblastoma of bone particularly (chondromatous osteoclastoma in Willis' terminology), there is a sharp divergence of opinion. This writer has observed material from fifteen or more relevant cases to date and is firmly convinced on the basis of evidence presented elsewhere (1942; and in the press) that the lesion in question represents a distinctive benign tumor of cartilage-forming connective tissue derivation and is unrelated histogenetically to giant-cell tumor.

Two of the papers in the same issue, by Prossor and Ellis respectively, purport to show the advantages of radiation therapy for giant-cell tumor. The first of these deals with a rather miscellaneous group of skeletal lesions, including many in young patients, most of which were not identified by biopsy prior to irradiation. In lieu of histological proof it is stated that the " radiographs showed benign giant-cell tumor." There is more involved than semantics in pointing out that radiographs cannot possibly show a giant-cell tumor. They show a defect or a lesion in the affected bone interpreted as a giant-cell tumor, and Brailsford to the contrary notwithstanding, there are very definite inherent limitations in the matter of interpretation, as Prossor himself freely admits. If one elects to irradiate a lesion presumed to be a giant-cell tumor without confirmation by at least punch biopsy, that is his privilege, but by the same token, there is little justification for presenting such observations as scientific evidence.

The validity of this objection is recognised in the paper by Ellis, but here again, almost half the cases presented are in patients between the ages of ten and twenty years, and much of the sketchily reported pathologic data in support of the diagnosis appears to be of equivocal or dubious nature. It is unfortunately

Jaffe, Portis and Lichtenstein (1940): *Archives of Pathology*, **30,** 993.
Jaffe, Sutro and Lichtenstein (1941): *Archives of Pathology*, **31,** 731.
Lichtenstein (1942): *American Journal of Pathology*, **18,** 969.
Lichtenstein (*in the press*): *Cancer.*

true that many lesions are still labelled giant-cell tumor by pathologists with limited experience in bone pathology, simply because they contain a scattering of multinuclear cells. The inclusion of dubious cases also detracts from the value of the paper by Windeyer and Woodyatt, and in the absence of convincing proof, the writer would seriously question, for example, whether the cases illustrated in Figures 5 and 6, and 13 and 14 represent osteoclastomas as stated.

In the provocative paper by Professor Russell entitled "Malignant Osteoclastomata," the view is expressed that the grading of giant-cell tumors on the basis of changes in their stromal cells, as advocated by Jaffe, Portis and myself, appears valueless. On reading further, one finds that this categorical statement is based upon inferences gleaned from a single case which Russell chooses to interpret as a malignant giant-cell tumor but which the writer feels may conceivably represent an osteogenic sarcoma. This same paper also raises an interesting problem of interpretation in regard to the nature of certain sarcomas developing in association with Paget's Disease. It is perhaps not generally appreciated that Paget's sarcoma may be of varying histologic types. Specifically, many, though by no means all, are osteogenic sarcomas, some are fibrosarcomas, and occasional ones are quite anaplastic and replete with tumor giant-cells. It is the latter tumors particularly that Russell regards as malignant osteoclastomas—a point of view that is rather debatable. Sarcomas of soft parts not infrequently come to contain numerous multinucleated tumor cells as an expression of rapid and unrestrained growth. When the same phenomenon is observed in relation to a sarcoma of bone, why should the latter necessarily be labelled as a malignant giant-cell tumor?

Finally, such unqualified statements as "osteoclastomata arise in the metaphyses of long bones . . ." and "bone cysts represent healed osteoclastic lesions" (appearing in one or another of the articles cited) would hardly meet with general acceptance.

Very truly yours,

August 24, 1949. LOUIS LICHTENSTEIN.

FROM PROFESSOR DOROTHY S. RUSSELL, M.D., SC.D., F.R.C.P., LONDON, ENGLAND

To the Editor,

Journal of Bone and Joint Surgery.

DEAR SIR,

Thank you for giving me the opportunity both of reading Dr Lichtenstein's letter before its publication and of answering those parts in which he refers to my article on "Malignant Osteoclastoma."

The pathologist who is confronted by a metastasis, as in my Case 2, which has the microscopical appearances of an ordinary benign osteoclastoma and is devoid of any unusual types of "stroma cells," must conclude that the latter are not essential to the clinical manifestations of malignancy. How then is it possible to subscribe to a system of grading which is based upon morphological alterations in the stroma cells? Dr Lichtenstein feels, alternatively, that the tumour in my Case 2 "may conceivably represent an osteogenic sarcoma." His opinion is of course based upon my account and photomicrographs. I don't believe that any competent pathologist would make such a diagnosis on the section, or that Dr Lichtenstein will maintain this view when he is able to examine it for himself.

With regard to Paget's osteitis deformans, it is of course generally known—at any rate by British pathologists—that the sarcomas complicating this condition are of various histological types. Hence it is surely not surprising if the malignant osteoclastoma should occasionally appear. But if Dr Lichtenstein's scepticism has really reached the point, as it would appear from his letter, of considering me guilty of confusing the osteoclastic type of giant cell with the multinucleate giant cells of osteogenic sarcoma, and of the anaplastic sarcomas of soft tissues, then I must regret his imputation of gross incompetence without the satisfaction of knowing precisely upon what this is based.

Yours truly,

October 17, 1949. DOROTHY S. RUSSELL.

Book Reviews

SURFACE AND RADIOLOGICAL ANATOMY FOR STUDENTS AND GENERAL PRACTITIONERS. By A. B. APPLETON, M.A., M.D. (Cantab.), Professor of Anatomy, London University (St Thomas's Hospital Medical School); W. J. HAMILTON, M.D., D.Sc., F.R.C.S.E., Professor of Anatomy, London University (Charing Cross Hospital Medical College), sometime Regius Professor of Anatomy, Glasgow University; and G. SIMON, M.D., D.M.R.E. (Cantab.), Demonstrator of Radiological Anatomy, St Bartholomew's Hospital Medical College, and Assistant Radiologist, St Bartholomew's Hospital. Third edition. 10× 8 in. Pp. viii+332, with 390 figures. Index and Appendix. 1949. Cambridge: W. Heffer & Sons, Ltd. Price 35/–.

This is the third edition of a book aiming to provide an " Introduction to the study of features which are accessible to examination in the living subject." This statement is too modest, for the book can be recommended also as a valuable reference work and companion for the post-graduate student and trainee specialist. It provides an atlas of normal surface and radiological anatomy and in addition illustrates deeper structures, mainly in relation to surface contours. In the last connection the book tends to deviate a little from its avowed purpose, by occasionally developing details of descriptive anatomy which are inappropriate. This, however, is a small point by comparison with the excellent radiological studies, and the relation of these to the living subject. For further editions, we would suggest the fuller use of illustrations depicting such common endoscopic examinations as those of the bladder, rectum and vagina. It is strange that these are missing when gastroscopy, an examination few men are likely to perform, is so beautifully illustrated. By comparison, the traditional sagittal sections of the cadaveric pelvis or head are rather out of place. As it is in the field of radiology that we think this book is so good, we venture to make our only serious criticism, namely, that it should be unnecessary to place arrows on so many of the obvious details presented by the radiographs. Students should be made to find out things for themselves from the descriptions given; radiologists should not be encouraged to commit the unforgivable sin of disfiguring their handiwork.—Norman CAPENER.

THE SCIENCE AND ART OF JOINT MANIPULATION—Vol. I—THE EXTREMITIES. By James MENNELL, M.A., M.D., Consulting Physician in Physical Medicine, St Thomas's Hospital, and former Lecturer to the Physiotherapy Training School. Hon. Fellow Chartered Society of Physiotherapy. Second edition. 10× 8 in. Pp. xv+215, with 299 figures. Index. 1949. London: J. & A. Churchill, Ltd. Price 24/–.

James Mennell

During all his professional career James Mennell has made a particular study of manipulation. For many years he was almost alone in his endeavours to show that this branch of Physical Medicine was an essential part of therapy. He knew the methods of the unorthodox, some of which led to cure and others to disaster. Some thirty years ago, he had to face the fact that the public looked primarily to the osteopath for manipulative treatment and the medical profession tended to scoff at it. At that time he was studying its rationale, which was hardly considered by the " manipulator." Gradually he has shown the great detail of his study of anatomy and physiology relating to manipulation and proved that the function of the limbs is a problem worthy of thought. His writings, based on a wide experience, have attracted the attention of English-speaking nations. He has spent many years in teaching the study of manipulation. A second edition of " The Science and Art of Joint Manipulation " is most welcome at this time when departments of physical medicine are developing all over the country. This volume concerns the extremities and we are promised a second volume on the spine in a matter of months.

The first chapters deal with basic considerations and useful rules for manipulation, without any attempt to enumerate the indications. The technique of manipulation of all limb joints is then described in meticulous detail, and warning is given of the dangers. The chapters on the finger joint and the knee are of outstanding value. The author stresses function and movement, especially in the smaller joints of which he has made a detailed study. He writes of treatment after manipulation. Almost avoiding terms such as rehabilitation and occupational therapy, he tells us the value of using the garden shears and a typewriter. Manipulation for dislocation or fracture is outside the scope of the book. The many figures, mostly from

photographs, are well chosen, especially those of manipulation of the knee. The art of manipulation is more easily learned by watching an expert than by looking at still photographs of him at work and, in consequence, Mennell is preparing sound films.

The production of this book is excellent, the arrangement is helpful, and the index is sufficient. Those practising orthopaedic surgery or physical medicine should read Mennell's work and realise the importance of the detail that he has been able to enunciate after many years of study—St J. D. BUXTON.

A COMPANION IN SURGICAL STUDIES. By Ian AIRD, Ch.M., F.R.C.S., Professor of Surgery in the University of London, Director of the Surgical Unit, Postgraduate Medical School of London. 10×8 in. Pp. viii+1060. Index. 1949. Edinburgh: E. & S. Livingstone, Ltd. Price 63/-.

Can a book of 1000 pages on surgery without a single illustration be anything but dull? Aird's book proves the contrary. It is easy to read, and on opening the book at random one is inclined, as with all good literature, to continue browsing. The book fulfils admirably the author's intention of giving a post-graduate a "contemporary view of general surgery and all surgical specialities other than his own." It is not written for the undergraduate nor is it a treatise on operative surgery. Its chief merit lies in the author's knowledge of current surgical literature; there are many thousands of references to papers published in the past ten years. If it has a fault, it lies in its lack of discrimination between the important and the unimportant; for example, twenty-five varieties of tumours of the kidney are listed. Unfortunately for the orthopaedic surgeon, the book does not cover the whole of surgery; the author has intentionally omitted all reference to orthopaedics.—George PERKINS.

PATHOLOGY OF THE NERVOUS SYSTEM. By J. Henry BIGGART, C.B.E., M.D., D.Sc., Professor of Pathology, Queen's University, Belfast; Pathologist to the Royal Victoria Hospital, Belfast Hospital for Sick Children, Claremont Street Hospital for Nervous Diseases, Mater Infirmorum Hospital. Foreword by Professor A. Murray Drennan, M.D., F.R.C.P.E., F.R.S.E. Second edition. 9×6 in. Pp. xii+352, with 232 figures and 10 coloured plates. Index. 1949. Edinburgh: E. & S. Livingstone, Ltd. Price 21/-.

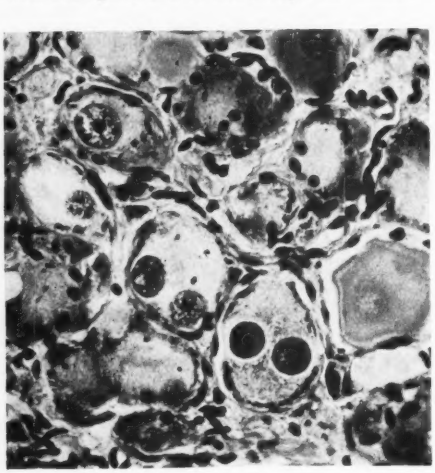


FIG. 222
Ganglioneuroma of the right adrenal in a child of eight years. Section is taken from one of the cellular areas. Note the mature cells and their capsules. Many are binucleated. Nissl substance is confined to the periphery of the cytoplasm. H. and E. ×320.

It is a pleasure to welcome the second edition of this useful introduction to the pathology of the nervous system. It contains a considerable amount of new matter throughout and many fresh illustrations, including the ten coloured plates. The latter are all excellent, although Plates V and X show nothing that would not have been equally clear in monochrome. Indeed the illustrations throughout are excellent and well amplify the text. The author has managed to cover the subject remarkably completely, and there are very few abnormalities of the nerve cell or system diseases which do not receive at least passing mention. It is a necessary fault in a text-book of this size that fuller descriptions of many of the rarer conditions have to be omitted, or reduced to a minimum. Sometimes the author appears to hurry from one matter to the next with almost breathless haste. The subject is large, and expanding rapidly, so that what was a reasonable size for a text-book at the date of the first edition, now, thirteen years later, appears to cramp the subject. Or it may be that many conditions which were omitted from the first edition have been referred to in the second.

The best sections of the book appear to the reviewer to be Chapters V to VII dealing with infections, including encephalitis, and Chapters XII and XIII on tumours of the nervous system. Both these are copiously and well illustrated. The chapter on encephalitis has been largely brought up to date, although the most recent work on insect vectors in Japanese B. encephalitis and the tick-borne Russian encephalomyelitis are not mentioned. The chapters on tumours include descriptions of all the more common forms, and the author's special interest in the pituitary gland is reflected in the excellence of the description of pituitary tumours. The least satisfactory chapter is that on injury. In this, the important work of Denny-Brown and Russell on "acceleration concussion" is referred to so briefly that its nature, and the conclusions to be drawn from

it, remain obscure; the bibliography omits their paper. No mention is made of the more recent experimental work and observations of American writers on neuronal damage in concussion of the brain or spinal cord. This work has so changed our conception of concussion from that of ten years ago that the omission is regrettable. Nor has the work on injuries of the peripheral nerves carried out during the war years found any reflection in the chapter on that subject. An impression is conveyed here, no doubt unintentionally, that any swelling at the junction of a severed peripheral nerve indicates an unsatisfactory union.

Taken as a whole this is a book which should admirably serve its purpose of stimulating the student by revealing the richness of the field of neuropathology, and showing how closely this subject is related to the pathology of other bodily systems.—J. G. GREENFIELD.

AN ACCOUNT OF THE SCHOOLS OF SURGERY, ROYAL COLLEGE OF SURGEONS, DUBLIN 1789–1948. By J. D. H. WIDDESS, M.A. (Dublin), L.R.C.P. & S.I., Librarian and Lecturer in Biology, R.C.S.I. Foreword by William Doolin, F.R.C.S.I., Hon. Librarian, Royal College of Surgeons in Ireland, Editor of the Irish Journal of Medical Science. $9\frac{3}{4} \times 6\frac{1}{2}$ in. Pp. x+107, with 16 plates. Bibliography, Appendix and Index. 1949. Edinburgh: E. & S. Livingstone, Ltd. Price 17/6.

Although the date 1789 appears in the title of this book, its opening pages cover the history of Irish surgery for many earlier centuries, but such an introduction is necessary if the reader is to understand how the need for the new institution arose. The steps taken by the founders of the College arouse admiration for their vision, courage and faith which overcame almost insuperable difficulties. The author, who is librarian and lecturer in biology in the College, illuminates with his knowledge every aspect of its early days and its later developments; he uses admirably brief and direct statement to convey the most comprehensive information in the least possible space; the work will prove invaluable for reference not only on matters directly concerning the College but on many related subjects; of these the story of the resurrectionists is given in graphic detail. There are many vivid biographical sketches of the staff of the College and its distinguished sons, where the use of concise quotation renders the figures three-dimensional. These quotations are very numerous, so that limitations of space may account for the absence of references. Dr Widdess includes not only the personalities who brought to the school its early success and established its later reputation, but also describes its buildings, furnishings, locality, syllabus, fees, examinations and resolutions, its prizes, its documents and its books. The excellent plates illustrate some of the records and show many portraits of men whose names are now perpetuated in anatomical structures or clinical signs. In consequence of the author's familiarity with early medical journals, their views of the school are extensively quoted, so that its early years are seen through the eyes of contemporaries.

The policy of the College was remarkably enlightened from its very start; it anticipated many current views on medical teaching and long ago introduced methods which remain hoped-for reforms elsewhere. In its first twenty years the College revolutionised surgical teaching in Dublin. Outstanding among its achievements was Colles's work in relating anatomy to surgery, while Macartney was the first teacher in Great Britain and Ireland to break away from the renaissance tradition and to teach anatomy on topographical instead of systemic lines. As early as 1841 the College established a chair of preventive medicine and the course of study came gradually to embrace all subjects required for general practice, but it is notable that at its very inception space was found for instruction in the history of medicine. The expansions which took place in 1805–10 and again in 1825 with government support were but preludes to a programme which was soon to make the College a great national institution, and culminated in its absorption of two private schools in 1889, an incident commemorated in its title "Schools." Had the founders taken as its motto *Tandem fit surculus arbor*, the College would have nobly justified their choice.

There are few misprints and the book fully maintains the high standard of its producers. There is a good index and there are some useful appendices, but the brief bibliography appears to do little justice to the author's reading.—John KEEVIL.

ERNIA DEL DISCO E SCIATICA VERTEBRALE. By Francesco DELITALA, Ordinario di Clinica Ortopedica, Direttore dell'Instituto Rizzoli di Bologna; and Augusto BONOLA, Primo Aiuto dell'Instituto Rizzoli, Inc. di Clinica Ortopedica dell'Univer. di Modena. $9\frac{1}{2} \times 6\frac{3}{4}$ in. Pp. 213, with 108 figures. Bibliography. 1949. Bologna: Licinio Capelli. Price, Lire 1800.

This is a comprehensive presentation of hernia of the intervertebral disc and its relation to sciatica. The subject is covered systematically in great detail and with great care. Particular attention is paid to the histo-pathology of the condition, and the clinical aspects and details of operative treatment are adequately discussed. The illustrations are delightful, and even those who were ignorant of the language could almost read the book by looking at the pictures. The bibliography covers the whole of the literature on intervertebral lesions and it is probably the most valuable part of the book.—Bryan MCFARLAND.

BOOKS RECEIVED

These books are acknowledged with grateful thanks. Selections will be made for review as space permits and in the interest of our readers.

MAJOR ENDOCRINE DISORDERS. By S. Leonard Simpson, M.A., M.D., F.R.C.P. 1948. London: Oxford University Press.

CAMPBELL'S OPERATIVE ORTHOPEDICS. Editor, J. S. Speed, M.D.; Associate Editor, Hugh Smith, M.D. Second edition. 1949. London: Henry Kimpton.

ILLUSTRATIONS OF SURGICAL TREATMENT. Instruments and Appliances. By Eric L. Farquharson, M.D., F.R.C.S. (Ed.), F.R.C.S. (Eng.). Foreword by the late Sir John Fraser, Bt., K.C.V.O., M.C., M.D., Ch.M., F.R.C.S. (Ed.). 1949. Edinburgh: E. & S. Livingstone, Ltd.

L'ORGANISATION DES OS. By P. Lacroix. 1949. Paris: Masson et Cie.

ON THE CONTRIBUTIONS OF HUGH OWEN THOMAS, SIR ROBERT JONES, JOHN RIDLON, M.D., TO MODERN ORTHOPEDIC SURGERY. By H. Winnett Orr, M.D. With a Supplement on RIDLON AND HIS SHARE IN MOULDING ORTHOPEDIC SURGERY, by Arthur Steindler, M.D. 1949. Illinois, U.S.A.: Charles C. Thomas. Oxford: Blackwell Scientific Publications, Ltd.

TUMOURS OF BONE. By Charles F. Geschickter, M.D., and Murray M. Copeland, M.D. Third edition. 1949. Philadelphia, London, Montreal: J. B. Lippincott Company.

ARMY FOOT SURVEY. An Investigation of Foot Ailments in Canadian Soldiers. By Colonel R. I. Harris, M.C., R.C.A.M.C., and Major T. Beath, R.C.A.M.C. 1947. Ottawa: National Research Council of Canada.

FRACTURES AND DISLOCATIONS IN GENERAL PRACTICE. By John Hosford, M.S., F.R.C.S. Second edition revised by W. D. Coltart, M.B., F.R.C.S. 1949. London: H. K. Lewis & Co., Ltd.

THE MEDICAL ANNUAL, 1949. Bristol: John Wright & Sons, Ltd.

X-RAY DIAGNOSIS FOR CLINICAL STUDENTS AND PRACTITIONERS. By G. Simon, M.D., B.Ch. (Cantab.), F.F.R. 1949. Cambridge: W. Heffer & Sons, Ltd.

ANKYLOSING SPONDYLITIS. Part I by F. Hernaman-Johnson, M.D., F.F.R., D.M.R.E. Part II by W. Alexander Law, O.B.E., M.D., F.R.C.S. 1949. London: Butterworth & Co. (Publishers), Ltd.

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